

11-20-00

3c714 U.S. PTO

**PATENT APPLICATION TRANSMITTAL LETTER**  
(Large Entity)

A

Docket No.  
**NORT0070US(12011RRUS02U)**

TO THE ASSISTANT COMMISSIONER FOR PATENTS

Transmitted herewith for filing under 35 U.S.C. 111 and 37 C.F.R. 1.53 is the patent application of:

**Peter A. Barany, Chandra Sekbar Bontu, and Shamim Akbar Rahman**

For: **Communicating Traffic Over a Wireless Channel in a Mobile Communications System**

Enclosed are:

- ☒ Certificate of Mailing with Express Mail Mailing Label No. **EL669041244US**
- ☒ 14 sheets of drawings.
- ☐ A certified copy of a application.
- ☒ Declaration ☒ Signed. ☐ Unsigned.
- ☒ Power of Attorney
- ☐ Information Disclosure Statement
- ☐ Preliminary Amendment
- ☒ Other: **Recordation Form Cover Sheet and Assignment**

**CLAIMS AS FILED**

For	#Filed	#Allowed	#Extra	Rate	Fee
<b>Total Claims</b>	48	- 20 =	28	x \$18.00	\$504.00
<b>Indep. Claims</b>	6	- 3 =	3	x \$80.00	\$240.00
<b>Multiple Dependent Claims (check if applicable)</b> <input type="checkbox"/>					\$0.00
<b>BASIC FEE</b>					\$710.00
<b>TOTAL FILING FEE</b>					\$1,454.00

- ☒ A check in the amount of **\$1,454.00** to cover the filing fee is enclosed.
- ☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. **20-1504** as described below. A duplicate copy of this sheet is enclosed.
- ☐ Charge the amount of as filing fee.
- ☒ Credit any overpayment.
- ☒ Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17.
- ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).

Dated: 11/17/00

*Dan C. Hu*  
Signature

**Dan C. Hu, Reg. No. 40,025**  
**Trop, Pruner & Hu, P.C.**  
**8554 Katy Freeway, Suite 100**  
**Houston, TX 77024**  
**(713) 468-8880 [Ph]**  
**(713) 468-8883 [Fax]**



**21906**

PATENT TRADEMARK OFFICE

CC:

APPLICATION  
FOR  
UNITED STATES LETTERS PATENT

TITLE: COMMUNICATING TRAFFIC OVER A  
WIRELESS CHANNEL IN A MOBILE  
COMMUNICATIONS SYSTEM

APPLICANTS: PETER A. BARANY, CHANDRA SEKHAR  
BONTU, AND SHAMIM AKBAR RAHMAN

Express Mail No.: EL669041244US

Date: November 17, 2000

COMMUNICATING TRAFFIC OVER A WIRELESS  
CHANNEL IN A MOBILE COMMUNICATIONS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application Serial No. 60/175,329, entitled "GSM/EDGE Radio Access Network (GERAN) Real-Time Fast Associated Control Channel (RTFACCH)," filed January 10, 2000.

TECHNICAL FIELD

The invention relates to communicating traffic in a mobile communications system.

BACKGROUND

Mobile communications systems, such as cellular or personal communications services (PCS) systems, are made up of a plurality of cells. Each cell provides a radio communications center in which a mobile station establishes a call with another mobile station or wireline unit connected to a public switched telephone network (PSTN). Each cell includes a radio base station, with each base station connected to a base station controller or mobile switching center that controls processing of calls between or among mobile stations or mobile stations and PSTN units.

Various wireless protocols exist for defining communications in a mobile network. One such protocol is a time-division multiple access (TDMA) protocol, such as the TIA/EIA-136 standard provided by the Telecommunications Industry Association (TIA). With TIA/EIA-136 TDMA, each channel carries a frame that is divided into six time slots to support multiple (3 or 6) mobile stations per channel. Other TDMA-based systems include Global System for Mobile (GSM) communications systems, which use a TDMA frame divided into eight time slots (or burst periods).

Traditional speech-oriented wireless systems, such as the TIA/EIA-136 and GSM TDMA systems, utilize circuit-switched connection paths in which a channel portion is occupied for the duration of the connection between a mobile station and the mobile

switching center. Such a connection is optimum for communications that are relatively continuous, such as speech. However, data networks such as local area networks (LANs), wide area networks (WANs), and the Internet use packet-switched connections, in which communication between nodes on a communications link is by data packets.

- 5 Each node occupies the communications link only for as long as the node needs to send or receive data packets. Popular forms of communications over packet-switched networks include electronic mail, web browsing, text chat sessions, file downloads, and other types of data transfers.

10 Several packet-switched wireless connection protocols have been proposed to provide more efficient connections between a mobile station and a data network. One such protocol is the General Packet Radio Service (GPRS) protocol, which complements existing GSM systems. Another technology that builds upon GPRS is the Enhanced Data Rate for Global Evolution (EDGE) technology, which offers even higher data rates. The enhancement of GPRS by EDGE is referred to as Enhanced GPRS (EGPRS). Another variation of EGPRS is the COMPACT technology. GPRS, EGPRS, and COMPACT are established by the European Telecommunications Standards Institute (ETSI).

15 The packet-switched wireless connection protocols provide efficient access to data networks, such as the Internet, LANs, WANs, and the like. A growing use of such data networks is for voice and other forms of real-time or streaming communications (such as video, audio and video, multimedia, and so forth). Various protocols have been defined to enable such real-time or streaming communications over the data networks, with one popular type of packet-switched network being the Internet Protocol (IP) network.

20 In some wireless communication systems, mobile stations are able to enter into a discontinuous transmission (DTX) mode. When a mobile station is not transmitting, such as when a user is not talking, and there is no other traffic to communicate, the mobile station can enter into DTX mode to save power and also to reduce interference with other mobile stations. During DTX, a channel between the mobile station and the base station is idle (that is, no traffic is being communicated). However, other mobile stations do not have access to the idle channel, since the channel is dedicated to the voice user. This is to ensure that the voice user can quickly start communicating over the channel once the user

resumes talking. As a result, available bandwidth is wasted in some mobile communications systems.

### SUMMARY

5 In general, according to one embodiment, a method of communicating in a mobile communications system comprises detecting that a first mobile station has stopped transmitting traffic containing real-time, interactive data on a first channel portion. Traffic from a second mobile station is multiplexed on the first channel portion during a period in which the first mobile station is not transmitting traffic.

10 Some embodiments of the invention may have one or more of the following advantages. Bandwidth of channel portions in a wireless communications system is increased by multiplexing traffic from another mobile station when a first mobile station has stopped transmitting real-time, interactive traffic (e.g., voice), such as during discontinuous transmission (DTX) mode. A reliable mechanism is provided to ensure  
15 that the first mobile station can quickly gain access back to the channel portion if the first mobile station starts transmitting again. This may be particularly useful when the traffic communicated by the first mobile station includes voice or other forms of real-time, interactive data.

20 Other features and advantages will become apparent from the following description, from the drawings, and from the claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of an embodiment of a mobile communications system.

25 Fig. 2 illustrates multiplexing of traffic transmitted by first and second mobile stations, in accordance with an embodiment.

Fig. 3 is a message flow diagram of messages exchanged between, and actions performed by, a mobile station and a base station, in accordance with one embodiment.

Figs. 4A-4B are a block diagram of components of the communications system of Fig. 1.

Fig. 5 illustrates a message transmitted by a first mobile station after exiting discontinuous transmission (DTX) mode to request allocation of the traffic channel portion that has been allocated to a second mobile station.

Fig. 6 illustrates an uplink assignment message to assign the channel portion back to the first mobile station.

Fig. 7 is the flow diagram of a process performed by a base station, in accordance with an embodiment.

Figs. 8A-8B and 9A-9B illustrate multiframes for carrying traffic and control signaling between the mobile station and the base station.

Fig. 10 illustrates the communications of a resource request message at different times and the communications of the responsive uplink assignment messages, in accordance with an embodiment.

Fig. 11 is a block diagram of a circuit to detect for the resource request message, in accordance with one embodiment.

### DETAILED DESCRIPTION

In the following description, numerous details are set forth to provide an understanding of the present invention. However, it will be understood by those skilled in the art that the present invention may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible. For example, although reference is made to General Packet Radio Service (GPRS) systems in described embodiments, other types of wireless systems that enable packet-switched communications by a base station may be employed in other embodiments.

Referring to Fig. 1, a mobile communication system 10, which may be a cellular or a personal communications services (PCS) system, includes a radio access network (RAN) 11 that includes base stations 12 having transceivers to transmit and receive radio frequency (RF) signals. The base stations 12 are coupled to a system controller 50, with each base station controlling communications with mobile stations in respective cells, cell sectors, or other cells segments. Examples of mobile stations that can communicate with the RAN 11 over RF channels include mobile telephones, mobile computers, personal digital assistants (PDAs), and other types of mobile stations.

In one embodiment, the radio access network 11 is an EGPRS (Enhanced GPRS or General Packet Radio Service) network that is able to support packet-switched data services. Alternatively, the radio access network may be a GPRS or a COMPACT network, or other types of wireless networks that are capable of supporting packet-switched data services, including a code-division multiple access (CDMA) network. The GPRS, EGPRS, and COMPACT protocols are set by the European Telecommunications Standards Institute (ETSI). As used here, reference to a "GPRS system" or "GPRS network," refers to any one of the GPRS, EGPRS, and COMPACT systems or networks.

In the GPRS network 11, the system controller 50 is a serving GPRS support node (SGSN), which is connected to the base station 12 over an Iu-ps interface. The SGSN 50 is also coupled to a gateway GPRS support node (GGSN) 52 over a Gn interface, which forms the gateway between the radio access network 11 and a packet-based data network 54, such as the Internet. Various network devices (not shown), such as a network telephone, a computer system, an Internet appliance, and so forth, are coupled to the packet data network 54. Some of the network devices are capable in participating in a real-time, interactive call session (e.g., a voice session, video conferencing session) with a mobile station through the radio access network 11. In addition, the packet data network 54 may be coupled through a gateway system 56 to a public switched telephone network (PSTN) 58, which is coupled to wireline telephones. Each mobile station is also capable of participating in a voice call session with the wireline telephone through the radio access network 11, packet data network 54, gateway system 56, and PSTN 58.

A "real-time, interactive" communications session refers to an exchange of data, such as audio and/or video data, on a substantially real-time basis between two terminals. A session is substantially real-time if interaction is occurring between two endpoints or parties, with a communication from one end point followed relatively quickly by a response or another communication from the other endpoint, typically within seconds, for example. Any substantial delay in the transmission of frames or packets carrying information associated with real-time, interactive communications may result in perceived degradation of the quality of the communications or in the reliability of the communications.

One type of packet-switched communications includes communications according to the Internet Protocol (IP). One version of IP is described in Request for Comments (RFC) 791, entitled "Internet Protocol," dated September 1981; and another version of IP is described in RFC 2460, entitled "Internet Protocol, Version 6 (IP v6 Specification)", dated December 1998. Packet-switched networks such as IP networks communicate with packets, datagrams, or other units of data over networks. Unlike circuit-switched networks, which provide a dedicated end-to-end connection or physical path for the duration of a communications session, a packet-switched network is based on a connectionless, internetwork layer. Routing of packets is based on destination addresses carried in the packets. The packets may be transmitted along different paths, and thus, may arrive at a destination in an order that is different than the transmission order. The destination terminal reassembles the received packets.

As shown in Fig. 1, mobile stations 34 and 40 are performing voice communications. In the example, the voice communications is referred to as VoIPoEGPRS (voice over IP over EGPRS), which refers to voice carried in IP packets that are in turn carried in EGPRS frames between the mobile stations and the radio access network 11. Instead of voice, the mobile stations 34 and 40 are also capable of communicating other types of real-time, interactive data, such as video data, multimedia data, and so forth.

The mobile stations 34 and 40 associated with voice or other real-time, interactive users, communicate with the radio access network 11 over wireless channels 18, 20, 22, 24, 26, 28, 30, and 32. The other mobile stations in the illustrated example include mobile stations 36 that are receiving electronic mail, mobile stations 38 that are transmitting electronic mail, and mobile stations 42 that are performing web browsing communications. Channels 14 and 16 are indicated as being available for other users.

As used here, a "channel portion" or "wireless channel portion" refers to a time slot of a frame transmitted on a given channel having a predetermined frequency. In a TDMA system such as an EGPRS system, each frame is divided into multiple time slots (e.g., 8 in the EGPRS system). For full-rate users, each time slot is allocated to carry bearer traffic of a mobile station. For half-rate users, each time slot is allocated to carry bearer traffic of two mobile stations. In other embodiments, the channel portion can be a



portion of another type of channel, such as a channel in a code-divisional multiple access (CDMA) system.

To enhance the bandwidth for communications with the various mobile stations in the radio access network 11, multiplexing of traffic is performed when the mobile stations 34 and 40 (associated with voice or other real-time, interactive data users) are in discontinuous transmission (DTX) mode and thus not transmitting traffic. When that occurs, the radio access network 11 allocates the channel portion that is used by the voice user mobile station (currently in DTX mode) to another mobile station, such as one of mobile stations 36, 38, and 42 (which are communicating packet traffic) or to another mobile station that is communicating real-time, interactive data or streaming data.

On the downlink path, multiplexing of plural mobile stations, even if one is a voice user, is relatively simple to implement since the base station is aware of the traffic that needs to be transmitted downlink. However, in the uplink path, to provide adequate performance, a mechanism in accordance with some embodiments is provided to enable the voice user mobile station to request the channel portion that has been relinquished to another mobile station while the voice user mobile station is in DTX mode. The time between the request and the re-allocation of the channel portion is relatively small to ensure that voice traffic is not substantially delayed. The mechanism to enable the request and assignment of a channel portion for a mobile station exiting DTX mode includes a Real-Time Fast Associated Control Channel (RTFACCH), as further described below.

Thus, using the RTFACCH mechanism, an on-demand feature is provided to the voice user mobile station for requesting re-allocation of a channel portion (e.g., time slot) that has been allocated to another mobile station during DTX mode of the voice user mobile station. The request for re-allocation can be transmitted in any frame (with certain exceptions) after the voice user mobile station detects that it has exited DTX mode. Thus, the voice user mobile station does not need to wait for a pre-assigned frame or block before it can send some indication that it has exited DTX mode and is ready to start communicating traffic again. Typically, allocation of blocks for communication of traffic is performed using either USF (Uplink State Flag), which is transmitted on the downlink path, or in an RRBP (Relative Reserved Block Period) field, also transmitted

on the downlink path. In fact, the voice user mobile station can transmit the request for re-allocation of the time slot during a period in which the other mobile station is transmitting traffic. As a result, mechanisms according to some embodiments are provided to detect the request despite the collision with traffic from the other mobile station on the same time slot (or channel portion).

In one embodiment, the radio access bearers of the GPRS network 11 include four different traffic classes (e.g., quality of service or QoS classes), including conversational traffic class, streaming traffic class, interactive traffic class, and background traffic class. The main factor that distinguishes these traffic classes from each other is how sensitive to delay they are. For example, the conversational traffic class includes traffic that is the most sensitive to delay, while the background traffic class includes traffic that is least sensitive to delay. Conversational and streaming traffic classes are primarily intended to be used for real-time traffic flows. The conversational traffic class includes real-time, interactive traffic, such as Internet telephony, while the streaming traffic class includes real-time traffic, such as transmissions of audio, video, or multimedia files that are being downloaded from a website to a terminal. Interactive and background traffic classes are primarily intended for use with non-real-time traffic flows, and include traffic flows associated with electronic mail, web browsing, file transfers, and so forth.

In the example of Fig. 1, mobile stations 34 and 40 are communicating traffic that are in the conversational traffic class, while mobile stations 36, 38, and 42 are communicating traffic that are in the interactive or background traffic class.

Referring to Fig. 2, multiplexing of traffic data from two mobile stations 100 and 102 on the same channel portion is illustrated. In one example, the mobile station 100 is communicating conversational class traffic, while the mobile station 102 is communicating interactive or background class traffic. However, in other examples, the mobile stations 100 and 102 may communicate other types of traffic.

As shown in Fig. 2, the mobile station 100 is communicating voice data with periods of silence (104, 106, and 108) corresponding to DTX mode of the mobile station 100 during which the user of the mobile station 100 is not speaking. During the silent periods 104, 106, and 108, data (represented as 110, 112, and 114) from mobile station 102 may be multiplexed onto the channel portion by a statistical multiplexer 116 that is

part of the radio access network 11. The combined flow of the multiplexed traffic from the mobile stations 100 and 102 are outputted by the statistical multiplexer 116.

As noted above, in an EGPRS system, each channel portion that is used to carry traffic from a mobile station includes one of eight time slots in a frame. In the case of the full-rate voice user (or other conversational traffic class user), the time slot is a dedicated time slot that is typically not shared with other mobile stations. This is because conversational traffic class users are more sensitive to delays. For half-rate users, each time slot is allocated to two mobile stations, but again, sharing is typically not performed during the allocated portions of the time slot for each mobile station. However, a substantial portion of the time slot allocated to a conversational class traffic mobile station is not used during DTX mode. To take advantage of this unused bandwidth, traffic from other mobile stations, such as the mobile station 102, can be multiplexed into the silent periods 104, 106, and 108. For optimal performance, the traffic that is multiplexed into the DTX periods includes traffic that is not sensitive to delays, such as traffic in the background or interactive traffic class. However, if delays associated with the multiplexing are not too excessive, multiplexing of voice traffic data between two conversational traffic class users may also be performed, in some embodiments.

Referring to Fig. 3, the process by which multiplexing of traffic from two mobile stations is enabled for a channel portion (referred to as “channel portion Y”) in the uplink path (from the mobile station to the base station 12) and subsequent allocation of the channel portion back to the mobile station is illustrated. The mobile station (“mobile station A”) sends speech frames (at 302) associated with a user (“user A”) to the base station 12 on channel portion Y. In one embodiment, the communication of speech frames occurs during talkspurt mode. When the mobile station detects (at 304) that user A has stopped talking, the mobile station enters (at 306) DTX mode. When it enters DTX mode, the mobile station sends (at 308) a message indicating that DTX mode is starting or has started. In one embodiment, the message is a SID\_FIRST frame, which is a marker to define the end of speech and the start of DTX mode. When the base station 12 receives the SID\_FIRST frame, the base station 12 assigns (at 310) channel portion Y to another mobile station (“mobile station B”). At this point, mobile station A is silent while mobile station B is transmitting on the uplink channel portion Y.

During DTX mode, mobile station A keeps its uplink TFI (temporary flow identifier) of a TBF (temporary block flow). Normally, the TFI is used to identify one of multiple users on the same channel portion (for interactive or background class traffic, for example). Under EGPRS, the TFI is a 5-bit value, thus enabling up to 32 users on the same channel portion. Although mobile station A maintains its TFI value, radio resources of channel portion Y can be allocated to another mobile station. Also, the packet timing advance control channel (PTCCH) that is assigned to mobile station A can be relinquished to the other user.

However, although radio resources have generally been relinquished to mobile station B during DTX mode of mobile station A, control messages for maintenance purposes are still needed for mobile station A. For that reason, such control messages are communicated at set periods in the uplink path. The control messages include the SID\_UPDATE message, which is used to communicate comfort noise parameters. Also, during the set periods, mobile station A can transmit PTCCH (packet timing advance control channel) to maintain time alignment; PACCH (packet associated control channel) to transmit control messages such as a channel quality message that includes parameters for link adaptation; RTCP (Real-Time Protocol Control Protocol) messages to provide feedback on the quality of real-time data communicated in the downlink path; and RSVP (Resource ReserVation Protocol) Time Values objects to refresh the QoS path in the network. RTP is described in RFC 1889, entitled "RTP: A Transport Protocol for Real-Time Applications," dated January 1996; and RSVP is described in RFC 2205, entitled "Resource ReSerVation Protocol: Version 1 Functional Specification," dated September 1997.

At a later point in time, mobile station A detects (at 312) that user A has started talking again. As a result, mobile station A sends (at 314) an indication to the base station 12 that mobile station A again needs channel portion Y. In one embodiment, the message is in the form of an RTFACCH resource request message (RTRRM) sent by mobile station A to the base station 12. RTFACCH can also be used to carry an uplink assignment message (RTUAM), which is transmitted by the base station 12 (at 316) in response to RTRRM to assign uplink radio resources to mobile station A. Upon receipt of the RTUAM, mobile station A enters into talkspurt mode and again transmits (at 318)

speech frames on channel portion Y. Mobile station B is either put into a queue or reassigned another channel.

Referring to Figs. 4A-4B, some of the components of the mobile communications system 10 of Fig. 1 are illustrated in greater detail. A mobile station 200 communicates over a wireless link with a base station 202, which has an Iu-ps interface 236 that is coupled to the SGSN 50. The mobile station 200 includes an RF transceiver 227 that is connected to an RF antenna 228. The mobile station 200 also includes an RLC/MAC (radio link control/medium access control) layer 225. The RLC module provides a radio-solution-dependent reliable link, and the MAC module controls the access signaling (request and grant) procedures for the radio channel.

The RLC/MAC layer 225 also includes a transmit DTX (TX DTX) handler 220 that passes traffic frames to a TX RSS (transmit radio subsystem) 222 in the transceiver 227. Each frame passed to the TX RSS 222 includes bit fields containing the information bits, the audio coder/decoder (CODEC) mode indication, and a TX\_TYPE identifier to identify the content of the frame. The TX\_TYPE identifier can specify that the frame contains speech; SID\_FIRST to mark the end of speech; SID\_UPDATE to provide comfort noise parameters; ONSET to indicate that the beginning of a speech burst is about to begin; NO DATA to indicate that the frame contains no useful data and should not be transmitted over the air interface; and other information. The transceiver 227 also includes an RRM generator 223 for generating RTRRM messages. As will be discussed further below, an RTRRM message is a coded version of the TFI associated with the mobile station. The RRM generator 223 performs the coding in accordance with some embodiments.

The TX DTX handler 220 includes a voice activity detector to assess whether input signals contain speech or not. If there is no speech, then the TX DTX handler 220 sends an indication to the TX RSS 222 to enter DTX mode by setting the flag TX\_TYPE to the value corresponding to SID\_FIRST. When the TX RSS 222 receives a SID\_FIRST frame, radio transmission from the TX RSS 222 is cut off. The TX DTX handler 220 receives audio data from an audio CODEC 270, which is coupled to an analog-to-digital (A/D) and digital-to-analog (D/A) converter 272 that outputs audio data to a speaker 274 and receives input audio from a microphone 276.

During DTX mode, the TX RSS 222 is resumed at regular intervals for transmission of SID\_UPDATE frames to communicate comfort noise parameters calculated in the TX DTX handler 220. The TX RSS 222 includes a channel encoder to encode information to be communicated over the air link.

Frames received over the air are passed by the transceiver 227 up through the RLC/MAC layer 225 and upper layers (not shown). Received control messages are processed by the upper layers or by one or more software routines 212. Received speech messages are passed to the audio CODEC 270 for output on the speaker 274.

The statistical multiplexer 116 (Fig. 2) can be implemented in one or more layers of the base station 200 (e.g., the transceiver 227, RLC/MAC layer 225, and higher layers).

In one configuration, radio access bearer 0 (RAB0) is used, in which the RTP/UDP/IP (Real-Time Protocol/User Datagram Protocol/Internet Protocol) header of each speech frame is removed in the radio access network 11 on the downlink path before transmission to the mobile station. The RTP/UDP/IP header is then reconstructed by the mobile station. On the uplink path, the RTP/UDP/IP header is removed by the mobile station and then reconstructed in the radio access network 11. For the radio access bearer 1 and 2 (RAB1 and RAB2) configurations, the RTP/UDP/IP header (compressed or uncompressed) is communicated to/from the mobile station and radio access network 11. To generate or process RTP/UDP/IP headers, appropriate RTP, UDP, and IP stacks (not shown) are provided in the mobile station.

The various software layers, routines or modules in the mobile station 200 are executable on a control unit 208, which is connected to a storage unit 210. The mobile station 200 also includes an input/output (I/O) interface 218, which is connected to a keyboard 214 and a display 216.

The base station 202 also includes a transceiver 253 that is coupled to an antenna tower 251 and an RLC/MAC layer 255. The transceiver 253 includes a receive radio subsystem (RX RSS) 252 for receiving frames over the air link. The RX RSS 252 is connected to a receive DTX (RX DTX) handler 250 in the RLC/MAC layer 255. The RX DTX handler 250 is responsible for the overall DTX operation on the receive side. The RX RSS 252 continuously passes received traffic frames to the RX DTX handler

250. A flag RX\_TYPE is set by the RX RSS 252 to indicate how the frame is to be handled by the RX DTX handler 250. For example, the RX\_TYPE flag can indicate that the received frame includes speech or that the received frame includes a SID\_FIRST, SID\_UPDATE, or ONSET message.

5       The base station 202 includes a radio resource management (RRM) module 237 that receives indications (SID\_FIRST) that radio resources are available for statistical multiplexing because a mobile station has gone idle (e.g., DTX mode). When that occurs, the radio resources, in the form of a channel portion, are allocated to another mobile station for the uplink.

10       The base station 202 also includes a fast access module 242 to control the RTFACCH operation. The fast access module 242 detects for receipt of the RTRRM message, and in response to the RTRRM message, the fast access module 242 sends an RTUAM message to the mobile station 200 to re-assign a channel portion to the mobile station 200. The fast access module cooperates with one or more base station routines 234 to determine allocation of the channel portion. The fast access module 242 and the software routines 234 are executable on a control unit 230, which is coupled to a storage unit 234.

15       In accordance with some embodiments, decoding for presence of RTRRM on the channel portion is performed by an RTRRM detector 238 in the transceiver 253.

20       RTRRM is transmitted by the mobile station 200 during transmission of actual data traffic by another mobile station on the same channel portion. The RTRRM detector 238 is discussed in greater detail below in connection with Fig. 11.

25       Referring to Fig. 5, while mobile station 200A (400) is in DTX mode, mobile station 200B (402) is transmitting bursts 406 over the allocated channel portion (time slot TNx). To request re-assignment of the channel portion, the mobile station 200A sends the RTRRM frame 408 in the same time slot that it was assigned during its previous talkspurt mode. However, the mobile station 200A can send RTRRM on a new time slot if the radio access network 11 sends PACCH on the downlink during the silence period of mobile station 200A to indicate a new time slot and/or frequency assignment.

30       In accordance with some embodiments, the RTRRM frame 408 includes the 5-bit TFI of the mobile station 200A. Normally, the TFI is used to identify one of multiple

users on the same channel portion. In one embodiment, up to 32 users may be placed on the same time slot on the downlink and up to 7 users may be placed on the same time slot on the uplink, with the 5-bit TFI identifying one of the multiple users. In one embodiment, the 5 TFI bits are coded into 148 bits and sent over the entire burst 408, which in one embodiment is 156.25 symbols long (which corresponds to about 577 microseconds). Each information bit in the burst 408 has an information rate  $f_b$  of about 8.667 kilobits per second (kb/s). In one example, the 5 TFI bits are coded by using a maximal length sequence at a chip rate  $f_c$  equal to the EGPRS symbol rate of about 270.855 symbols per second, which results in a coding gain (CG) of 15 dB.

Each of the TFI bits is converted to one of two codes based on the state of the TFI bit. This coding is performed by the RRM generator 223 (Fig. 4A). If the TFI bit has state 0, then the bit is converted to the following 31-bit maximal length (ML) sequence:

Code-0 = 11110 11100 01010 11010 00011 00100 1.

If the TFI bit has state 1, then the bit is converted to the following ML sequence:

Code-1 = 11110 11001 11000 01101 01001 00010 1.

Since the TFI after coding results in a total of 155 bits ( $31 \times 5$ ), not 148, 7 bits are “punctured” or truncated. The punctured bits correspond to TFI bits 0 and 4; as a result, TFI bits 0 and 4 get less coding gain compared to the remaining TFI bits. In other embodiments, other coding schemes may be selected to achieve a more uniform coding gain for all five bits of TFI. In alternative embodiments, other codes can be used. Also, alternatively, instead of two codes, a single code can be used, with the states of the bits flipped to represent “0” and “1” states.

By using an RTRRM that is one burst in length, a relatively fast mechanism is enabled for re-assignment of the requested time slot back to the mobile station 200A. Also, to ensure reliable detection, RTRRM is transmitted at relatively high power, up to the maximum power permitted for the mobile station 200A. The transmission of the RTRRM burst 408 overlaps and coincides with the data traffic bursts 406 transmitted by



the mobile station 402. To detect the presence of RTRRM despite this collision, the RTRRM detector 238 in the base station 202 uses joint detection or successive cancellation techniques, as further described below. Optionally, RTRRM may also be independently detected.

Collision between the RTRRM burst 408 and the traffic burst 406 may or may not cause the traffic burst 406 to be corrupted. If the traffic burst 406 is corrupted, then the base station 202 may request retransmission of the traffic burst 406 from the mobile station 200B. If the traffic burst 406 from the mobile station 200B contains speech data, then a speech frame substitution technique may be used to recover corrupted speech data. In one example, the speech frame substitution technique involves substituting a previously received speech frame in place of the present frame if the present frame is corrupted.

Referring to Fig. 6, one embodiment of an RTUAM burst 500 is illustrated. The RTUAM burst 500 includes a header portion 502 that identifies the burst 500 as an RTUAM. The body of the RTUAM burst 500 includes the following: <TFI>, which represents the five-bit TFI; {0 | 1 <Uplink\_TFI\_ASSIGNMENT>}, which is used by the radio access network 11 to assign another TFI to the mobile station exiting DTX mode so that the mobile station transmits on a different time slot and/or RF frequency; <TSC>, which represents the training sequence code used for measuring co-channel interference; <ARFCN>, which represents the radio frequency of the channel assigned to the mobile station; <TIMESLOT\_ALLOCATION>, which contains the time slot assignment for the mobile station; and padding bits.

The RTUAM burst 500 is one burst in length to decrease the delay in re-assigning a time slot back to a mobile station exiting DTX mode. This is particularly important for mobile stations communicating conversational class traffic, which are the most sensitive to delay of the four possible traffic classes. To prevent collision between the RTUAM burst 500 and other data on the downlink, the base station will preempt transmission of any other data on the downlink. To improve reliability in detection of RTUAM, repetition diversity may be employed, as explained below. Also, in further embodiments, an RTUAM burst having a larger length may be employed to improve reliability.

Referring to Fig. 7, processing of various messages by the base station is illustrated. If the base station detects receipt of a robust AMR (adaptive multi-rate) traffic synchronized control channel (RATSCCH), the base station decodes the RATSCCH frame (at 604). The RATSCCH frame is used to convey RATSCCH messages and to change CODEC configurations on the radio interface. The RATSCCH frame is passed to the RX DTX handler 250 as a NO\_DATA frame.

If the base station detects (at 606) receipt of a SID\_FIRST frame, the frame is passed to the RX DTX handler 250 as the SID\_FIRST frame (at 608). In addition, the radio resource management (RRM) module 237 is notified that uplink radio resource is now available for statistical multiplexing. The base station also begins looking for an RTRRM burst, and if an RTRRM burst is received, a responsive RTUAM burst is transmitted to the mobile station.

The base station can also detect a SID\_UPDATE frame (at 610). In response, the frame is decoded and passed (at 612) to the RX DTX handler 250 as SID\_UPDATE, SID\_BAD or NO\_DATA frame depending on the CRC (cyclic redundancy check) and the content of information bits along with comfort noise parameters. Also, the base station checks to determine if the received message is a PACCH burst, PTCCH burst, or a PDTCH (packet data traffic channel) burst (containing RTCP or RSVP signaling). The purposes of these messages are discussed above. The base station continues to monitor for the RTRRM message, and if the RTRRM burst is detected, a responsive RTUAM burst is transmitted.

The base station can also detect (at 614) an ONSET frame, which is passed (at 616) to the RX DTX handler 250 as an ONSET frame. This indicates that an RTRRM burst has been detected, that the RTUAM has been transmitted in response to the RTRRM, and the RRM module 237 has been notified that the uplink radio resource is no longer available for statistical multiplexing.

If none of the RATSCCH, SID\_FIRST, SID\_UPDATE, and ONSET frames are detected, then the base station decodes (at 618) the received frame as a speech frame. If the SID\_FIRST frame has been previously detected with no subsequent detection of the ONSET frame, then the base station continues to monitor for the RTRRM message.

In an EGPRS system, multiframes are used to communicate control and traffic signaling between mobile stations and base stations. The multiframes can include 52 frames, with each frame containing eight time slots. A multiframe starts with frame FN0 and ends with frame FN51. Four frames make up a block. Generally, conversational traffic is interleaved over eight frames, while traffic in the other traffic classes is interleaved over four frames.

Referring to Figs. 8A-8B, according to one example, a multiframe 700 communicated in the uplink path and a multiframe 702 communicated in the downlink path are illustrated. The multiframes 700 and 702 each includes 52 frames FN0-FN51. Each frame has eight time slots TN0-7. According to one configuration, a speech frame (SF) is interleaved over eight frames. In the example shown in Figs. 8A-8B, time slot TN0 is assigned to carry speech associated with a first mobile station. Thus, as shown, speech frame 1 (SF#1) is interleaved over frame numbers FN0-7 (blocks B0 and B1). The last half of speech frame 0 (SF#0) is interleaved over frame numbers FN0-3. Speech frame 2 (SF#2) is interleaved over frame numbers 4-11 (block B1 and B2). SF#2 is the end of speech stream from the first mobile station, so that SID\_FIRST (F) frames are also interleaved over the frame numbers FN8-11 (block B3). Frame FN12 is used to carry the PTCCH (Packet Timing Advanced Control Channel).

Since the first mobile station (mobile station A) has entered into DTX mode, time slot TN0 in the subsequent frames of the multiframe can be allocated to a second mobile station (mobile station B) to carry traffic transmitted by mobile station B. As shown, traffic associated with mobile station B is carried in frames FN13-20 (blocks B4 and B5). The frames carrying traffic of mobile station B are marked with "MB".

In accordance with some embodiments, even though the first mobile station is in DTX mode, it continues to transmit SID\_UPDATE messages to convey comfort noise parameters. The SID\_UPDATE message is interleaved over frame numbers FN21-24 (block B6). In one embodiment, the SID\_UPDATE message is communicated by the mobile station in DTX mode every (N+1)th radio block, where N is set to some arbitrary value, e.g., N greater than or equal to 1. In the example illustrated in Figs. 8A-8B, N is equal to two. Also, at longer intervals, the same (N+1)th radio block may also be used for the following purposes: transmitting PTCCH information periodically; transmitting

control messaging through PACCH; transmitting RTCP packets through PDTCH; and transmitting RSVP Time Values objects through PDTCH.

After the idle frame FN25, frames FN26-33 (blocks B7 and B8) are used to carry traffic transmitted by mobile station B. Next, in frames FN34-37 (block B9), the  
 5 SID\_UPDATE frame is transmitted by the mobile station A. The next frame FN38 carries PTCCH information, followed by traffic from the mobile station B in frames FN39-42 (block B10). In addition, at this time, mobile station A has detected user voice traffic again and wishes to begin re-transmitting. To do so, mobile station A transmits RTRRM (represented by R) in frame FN 41 (which is also carrying traffic from the  
 10 mobile station B).

Generally, according to one embodiment, RTRRM can be transmitted on any frame number of a multiframe except the following:  $FN \bmod 52 = 12$  (which carries PTCCH), 25 (which is idle), 38 (which carries PTCCH), or 51 (which is idle).

In response to RTRRM in frame FN41, the base station transmits RTUAM  
 15 (represented as A) in frame FN42 of multiframe 702 (on the downlink). With RTUAM, the base station has allocated time slot TN0 in the multiframe 700 back to mobile station A. After being allocated back time slot TN0, mobile station A transmits the ONSET frame in frames FN43-46 (block B11). Mobile station A also starts transmitting speech frame 0 (SF#0) after exiting DTX mode. SF#0 is interleaved over eight frames FN43-50  
 20 (blocks B11 and B12). Mobile station A continues to transmit further speech frames.

On the downlink path, statistical multiplexing of traffic destined for two different mobile stations can also be performed. However, since the base station is aware of when it has entered DTX mode with one mobile station, it can easily multiplex the traffic from another mobile station during its silence period with the first mobile station. The  
 25 RTFACCH mechanism discussed for the uplink path is not required to perform statistical multiplexing on the downlink path. Thus, while mobile station A is transmitting speech frames on the uplink path in frames FN0-7 (blocks B0 and B1), the base station is not transmitting data on the downlink path, and thus the base station enters DTX mode on the downlink path to mobile station A. However, the same frames can be used to  
 30 communicate traffic to another mobile station (e.g., mobile station B). SID\_UPDATE frames are communicated on the downlink path from the base station to mobile station A

on frames FN8-11 (block B3) of the multiframe 702. After the base station allocates time slot TN0 back to mobile station A, the base station transmits the ONSET frame in frames FN13-16 (B4), along with speech frame 0 (SF#0). Further speech frames are communicated in subsequent frames of the multiframe 702, until the speech has stopped.

At that point, in frames FN34-37 (block B9), the SID\_FIRST message is transmitted downlink in frames FN34-37.

Next, the block (B10) starting at frame FN39 is used to carry traffic targeted for mobile station B since the downlink path from the base station to the first mobile station is now silent. However, the base station also detects transmission of the RTRRM message at this time (transmitted by the first mobile station in frame FN41). In response to detection of RTRRM, the base station preempts the transmission of traffic for mobile station B in frame FN42 and transmits RTUAM instead.

Figs. 8A-8B illustrate the minimum delay between when an RTRRM message is transmitted by the mobile station A after the re-establishment of uplink speech transmission by the first mobile station. In the example of Figs. 8A-8B, a one-frame delay is experienced between RTRRM and the start of speech transmission in frame FN43 in the uplink multiframe 700.

Referring to Figs. 9A-9B, a maximum delay scenario is illustrated. Figs. 9A-9B show a multiframe 800 on the uplink path and a multiframe 802 on the downlink path. The difference between the examples of Figs. 8A-8B and 9A-9B is that RTRRM is transmitted in frame FN42 in the multiframe 800 (instead of frame FN41 in the multiframe 700 of Figs. 8A-8B). Frame FN42 is the last frame of block B9. As a result, the assignment message RTUAM is not communicated until the beginning of the next block (B10) in frame FN43. As a result, the next block B10 on the uplink path is not allocated to the first mobile station (so that traffic from mobile station B continues to be transmitted in the uplink multiframe 800). It is not until block B11 of the uplink multiframe 800 that mobile station A can resume transmission of traffic in time slot TN0.

Referring to Fig. 10, the relative timing between RTRRM, RTUAM, and resumption of uplink transmission is illustrated, given different times at which RTRRM is sent. A downlink stream 900 and an uplink stream 902 of frames are illustrated. In the example of Fig. 10, time slot TN1 is the time slot used for communications by a first

mobile station (mobile station A). As shown in Fig. 10, the uplink stream is delayed with respect to the downlink stream by three time slots. The stream is divided into three blocks  $B_x$ ,  $B_{x+1}$ , and  $B_{x+2}$ . Assuming that mobile station A is in the DTX mode, there are four different possible time periods within a block that the first mobile station can transmit RTRRM to request the channel back. In a first scenario, the RTRRM can be sent in the last burst (or time slot) of a block  $B_x$  (as indicated by 904). When this occurs, the RTUAM is not transmitted on the downlink (at 912) by the base station in the downlink path until the next block ( $B_{x+1}$ ). In the next scenario, RTRRM can be transmitted in the uplink in the first burst of a block ( $B_{x+1}$ ) (as indicated at 906). RTRRM can also be transmitted in the second and third bursts of block  $B_{x+1}$  (as indicated by 908 and 910, respectively).

With RTRRM transmitted in the uplink path at 904 (the last burst of block  $B_x$ ), the responsive RTUAM message is communicated in the first burst of the next block  $B_{x+1}$  (as indicated by 912). However, for transmissions of RTRRM in the first, second and third bursts of block  $B_{x+1}$  (906, 908, and 910, respectively), the RTUAM is communicated in the last burst of block  $B_{x+1}$  (as indicated by 914) so that the base station has at least two or more bursts to detect the presence/absence of RTRRM on the uplink. In response to communication of RTUAM at 912 or 914, uplink traffic transmission from the first mobile station can resume in the first burst of the next block ( $B_{x+2}$ ), as indicated by 916.

For improved reliability in detection of RTRRM, repetition diversity may be used, in which RTRRM is transmitted multiple times. This is possible when RTRRM is transmitted in the first or second bursts of a block (such as at 906 and 908 in Fig. 10). To enable repetition of RTRRM, RTUAM is transmitted in the last burst of the block.

Repetition diversity can also be used for RTUAM by sending it at different times. For example, if RTUAM is sent in the first burst of a block, then RTUAM may be repeated three more times. The plural RTUAM bursts are independent of each other (each is self-sufficient), and they may employ different parity protection to enhance error protection. However, if RTUAM is sent on the third or fourth burst of a block, then the base station may not be able to perform repetition diversity for RTUAM.

In accordance with some embodiments of the invention, the joint 238 detector (Figs. 4A-4B) is used to simultaneously decode both RTRRM and traffic. As noted above, RTRRM comprises the 5-bit downlink TFI coded into 148 bits. The  $k$ th sample of the complex envelope of the received signal at the output of a base station receiver filter,  $r(kT)$  represented as  $r_k$  can be expressed as follows, when RTRRM is not present:

$$r_k = \sum_{i=0}^{L-1} c_i s_{k-i} + \sum_{i=0}^{N-1} e_i I_k^{(i)} + n_k \quad (\text{Eq. 1})$$

However, when RTRRM is present,  $r_k$  is expressed as follows:

$$r_k = \sum_{i=0}^{L-1} c_i s_{k-i} + \sum_{i=0}^{L-1} d_i p_{k-i} + \sum_{i=0}^{N-1} e_i I_k^{(i)} + n_k \quad (\text{Eq. 2})$$

In Eqs. 1 and 2 above, the value  $s_k$  is the  $k$ th sample of the information signal from the mobile station B. The value  $p_k$  is the  $k$ th sample of the RTRRM signal from the mobile station A, and  $n_k$  is the  $k$ th sample of the receiver noise. Also,  $I_k^{(i)}$  represents the  $k$ th sample of the  $i$ th interferer,  $\{c_i\}$  and  $\{d_i\}$  represent the channel impulse responses associated with mobile stations A and B, respectively.  $L$  is the length (in symbols) of the channel impulse response, and  $N$  represents the number of cochannel interferers.  $\{e_i\}$  is the channel weight associated with the  $i$ th interferer. Here, it is assumed that the interferer is passed through a flat fading channel.

In a given maximum likelihood sequence estimator (MLSE), the  $j$ th branch metric,  $\gamma_k^{(j)}$ , at time instant  $k$ , is calculated in the absence of RTRRM as follows:

$$\gamma_k^{(j)} = \left| r_k - \sum_{i=0}^{L-1} \hat{c}_i F(I^{(i \rightarrow j)}) \right|^2 \quad (\text{Eq. 3})$$

where  $F(I^{(i \rightarrow j)})$  represents the symbol vector of traffic from mobile station A resulting from the transition from the  $i$ th state at time  $(k-1)$  to the  $j$ th state at time  $k$ .  $\{\hat{c}_i\}$  represents the estimated channel impulse response.

The branch metric is modified to jointly decode the RTRRM and data from mobile station B as follows:

$$\gamma_k^{(j,m)} = \left| r_k - \sum_{i=0}^{L-1} \hat{c}_i F(I^{(i \rightarrow j)}) - \sum_{i=0}^{L-1} \hat{d}_i F(\text{Code} - m) \right|^2 \quad (\text{Eq. 4})$$

where the third term on the right-hand side of Eq. 4 corresponds to RTRRM and has two possible states ( $m=0$  or  $1$ ) corresponding to each of the two code waveforms (code-0 and code-1). Additionally, operations performed in decoding RTRRM include channel estimation during training sequence,  $\{\hat{d}_i\}$ , calculation of the branch metric corresponding to RTRRM for each of the two code waveforms ( $m=0$  and  $1$ ), and determination of the downlink TFI of the MS TBF.

In one arrangement, the third term on the right-hand side of Eq. 4 can be calculated on a continuous basis to check for the presence of RTRRM. However, in another arrangement, the third term of the right-hand side of Eq. 4 does not need to be continuously calculated to reduce processing load. In this other arrangement, the third term on the right-hand side of Eq. 4 is calculated only when it has been determined that RTRRM is present. One example of the detector 238 configured according to the latter arrangement is illustrated in Fig. 11. Received signal samples are inputted to a receive filter 1002. The output of the receiver filter 1002 is provided to a demodulator 1006 and an RTRRM switch control module 1004. The RTRRM switch control module 1004 detects for the presence or absence of RTRRM in the received signal. When the switch control module 1004 detects the presence of RTRRM, it activates an RTRRM switch 1008, so that the metric for RTRRM (1010) can be provided to the demodulator 1006 to decode for RTRRM. Thus, in the example of Fig. 11, if the received signal does not contain RTRRM, the demodulator 1006 decodes the received signal into data (associated with mobile station B). However, if the received signal contains RTRRM, then the demodulator 1006 decodes RTRRM for use in the base station.

The operations, tasks, and functions discussed herein that are performed in stations or systems in the mobile communications network 10 may be controlled by software applications, routines, or modules executable on control units, such as those



shown in Figs. 4A-4B. Each control unit includes a microprocessor, microcontroller, processor card (including one or more microprocessors or microcontrollers), or another control or computing device. As used here, a "controller" or a "control module" refers to hardware, software, or a combination thereof. A "controller" or "control module" can  
5 refer to a single component or to multiple components (hardware or software).

The storage units referred to herein include one or more machine-readable storage media for storing data and instructions. The storage media include different forms of memory including semiconductor memory devices such as dynamic or static random access memories (DRAMs or SRAMs), erasable and programmable read-only memories (EPROMs), electrically erasable and programmable read-only memories (EEPROMs),  
10 and flash memories; magnetic disks such as fixed, floppy and removable disks; other magnetic media including tape; and optical media such as compact disks (CDs) or digital video disks (DVDs). Instructions that make up the various software routines or modules in a station or system and stored in a respective storage unit when executed by a control unit cause the corresponding station or system to perform programmed acts.  
15

The instructions of the software routines or modules are loaded or transported into the station or system in one of many different ways. For example, code segments including instructions stored on floppy disks, CD or DVD media, a hard disk, or transported through a network interface card, modem, or other interface device are loaded  
20 into the station or system and executed as corresponding software routines or modules. In the loading or transport process, data signals that are embodied in carrier waves (transmitted over telephone lines, network lines, wireless links, cables, and the like) communicate the code segments, including instructions, to the station or system. Such carrier waves are in the form of electrical, optical, acoustical, electromagnetic, or other  
25 types of signals.

While the invention has been disclosed with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover such modifications and variations as fall within the true spirit and scope of the invention.

What is claimed is:

- 1           1.     A method of communicating in a mobile communications system,  
2 comprising:  
3                 detecting that a first mobile station has stopped transmitting traffic  
4 containing real-time, interactive data on a first channel portion; and  
5                 multiplexing traffic from a second mobile station on the first channel  
6 portion during a period in which the first mobile station is not transmitting traffic.
- 1           2.     The method of claim 1, further comprising receiving an indication that the  
2 first mobile station is starting to transmit traffic.
- 1           3.     The method of claim 2, further comprising allocating the first channel  
2 portion back to the first mobile station.
- 1           4.     The method of claim 1, wherein detecting that the first mobile station has  
2 stopped transmitting traffic comprises detecting that the first mobile station has entered a  
3 discontinuous transmission mode.
- 1           5.     The method of claim 4, wherein detecting that the first mobile station has  
2 entered discontinuous transmission mode comprises receiving a predetermined message  
3 indicating that the mobile station is entering the discontinuous transmission mode.
- 1           6.     The method of claim 1, wherein multiplexing the second mobile station  
2 traffic comprises receiving the second mobile station traffic on a predetermined time slot  
3 of a frame, the channel portion comprising the predetermined time slot.
- 1           7.     The method of claim 1, further comprising receiving a request from the  
2 first mobile station for the channel portion, the request indicating that the first mobile  
3 station is about to start transmitting traffic.

1           8.     The method of claim 7, wherein receiving the request comprises receiving  
2 a request that is one burst in length.

1           9.     The method of claim 8, wherein receiving the request comprises receiving  
2 a request that coincides with traffic from the second mobile station.

1           10.    The method of claim 9, further comprising extracting the request from a  
2 combined signal including the request and the traffic from the second mobile station.

1           11.    The method of claim 8, wherein receiving the request comprises receiving  
2 a request that is based on an identifier associated with the mobile station.

1           12.    The method of claim 11, wherein the identifier comprises a temporary  
2 flow identifier.

1           13.    The method of claim 11, wherein receiving the request comprises  
2 receiving a request that contains a coded version of the identifier, the coded version  
3 having a length that is longer than the identifier.

1           14.    The method of claim 7, wherein receiving the request comprises receiving  
2 the request during a period in which the second mobile station is transmitting traffic in  
3 the first channel portion.

1           15.    The method of claim 7, further comprising sending an assignment  
2 message to the first mobile station.

1           16.    The method of claim 15, wherein sending the assignment message  
2 comprises sending a one-burst assignment message.

1           17.    The method of claim 15, wherein sending the assignment message  
2 comprises sending a plural-burst assignment message.

1           18.    The method of claim 1, wherein detecting that the first mobile station has  
2 stopped transmitting traffic comprises receiving a General Packet Radio Service  
3 SID\_FIRST indication.

1           19.    The method of claim 18, further comprising receiving a Real-Time Fast  
2 Associated Control Channel resource request message from the first mobile station for re-  
3 assignment of the channel portion.

1           20.    The method of claim 19, further comprising sending a Real-Time Fast  
2 Associated Control Channel assignment message to the first mobile station to assign the  
3 channel portion back to the first mobile station.

1           21.    A system for use in a mobile communications system, comprising:  
2                   a wireless interface adapted to communicate over a wireless channel  
3 portion with a first mobile station; and  
4                   a controller adapted to detect if the first mobile station has entered into a  
5 discontinuous transmission mode and to allocate the wireless channel to another mobile  
6 station when the first mobile station is in the discontinuous transmission mode.

1           22.    The system of claim 21, wherein the wireless channel portion includes a  
2 time slot of a frame having plural time slots.

1           23.    The system of claim 21, further comprising a multiplexer to receive traffic  
2 from the first mobile station when the first mobile station is in an active mode and to  
3 receive traffic from the other mobile station when the first mobile station is in the  
4 discontinuous transmission mode.

1           24.    The system of claim 21, wherein the controller is adapted to detect a  
2 request from the first mobile station for re-allocation of the channel portion back to the  
3 first mobile station.

1           25.    The system of claim 24, wherein the request comprises a request carried in  
2   a General Packet Radio Service Real-Time Fast Associated Control Channel.

1           26.    The system of claim 25, wherein the request comprises a Real-Time Fast  
2   Associated Control Channel resource request message.

1           27.    The system of claim 24, wherein the controller is adapted to further send  
2   an assignment message to the first mobile station in response to the request.

1           28.    The system of claim 24, wherein the request has a length of one time slot  
2   of a frame.

1           29.    The system of claim 28, wherein the request is based on an identifier  
2   associated with the first mobile station.

1           30.    The system of claim 29, wherein the request is a coded version of the  
2   identifier associated with the first mobile station.

1           31.    The system of claim 24, wherein the request coincides with traffic from  
2   the other mobile station, the system further comprising a joint detector to extract the  
3   request from a combined message including the request and the traffic from the other  
4   mobile station.

1           32.    The system of claim 24, wherein the controller is adapted to receive the  
2   request during at the same time the controller is receiving traffic from the other mobile  
3   station.

1           33.    A mobile station comprising:  
2                   a detector to detect when the mobile station is entering discontinuous  
3 transmission mode;  
4                   a controller adapted to send an indication to a base station of the  
5 discontinuous transmission mode to indicate that a channel portion assigned to the mobile  
6 station is idle,  
7                   the controller adapted to further send a request for re-assignment of the  
8 channel portion when the mobile station exits discontinuous mode.

1           34.    The mobile station of claim 33, wherein the controller is adapted to send  
2 the indication according to a General Packet Radio Service protocol.

1           35.    The mobile station of claim 34, wherein the mobile station is associated  
2 with temporary flow identifier, the request being based on the temporary flow identifier.

1           36.    The mobile station of claim 35, further comprising a storage unit to store  
2 the temporary flow identifier, the mobile station keeping the temporary flow identifier  
3 during discontinuous transmission mode.

1           37.    The mobile station of claim 33, wherein the controller is adapted to further  
2 receive an assignment message responsive to the request and to transmit traffic on the  
3 channel portion after receiving the assignment message.

1           38.    The mobile station of claim 33, wherein the channel portion comprises a  
2 time slot of a frame.

1           39.    A system for use in a mobile communications system, comprising:  
2                   a wireless interface adapted to communicate over a wireless channel  
3 portion with one of a first mobile station and a second mobile station; and  
4                   a controller adapted to allocate the channel portion to the second mobile  
5 station when the first mobile station is silent and to receive a request from the first mobile

6 station for allocation of the channel portion while concurrently receiving traffic from the  
7 second mobile station.

1 40. The system of claim 39, wherein the channel portion comprises a time slot  
2 of a frame having plural time slots.

1 41. The system of claim 39, wherein the request comprises a General Packet  
2 Radio Service Real-Time Fast Associated Control Channel message.

1 44. An article comprising at least one storage medium containing instructions  
2 for communicating in a mobile communications network, the instructions when executed  
3 causing a system to:

4 detect a first mobile station entering discontinuous transmission mode, the  
5 first mobile station assigned a channel portion to communicate traffic; and

6 multiplex traffic from a second mobile station onto the channel portion  
7 during a time period in which the first mobile station is in discontinuous transmission  
8 mode.

1 45. The article of claim 44, wherein the instructions when executed cause the  
2 system to further receive a request from the first mobile station for a re-allocation of the  
3 channel portion.

1 46. The article of claim 45, wherein the channel portion comprises a time slot  
2 of a frame having plural time slots.

1 47. The article of claim 45, wherein the instructions when executed cause the  
2 system to receive the request from the first mobile station that overlaps traffic from the  
3 second mobile station.

1           48.    A data signal embodied in a carrier wave and comprising instructions for  
2 communicating in a mobile communications network, the instructions when executed  
3 causing a system to:

4                    receive an indication that a first mobile station is entering discontinuous  
5 transmission mode;

6                    allocate a channel portion assigned to the first mobile station to a second  
7 mobile station;

8                    receive traffic from the second mobile station during a time period in  
9 which the first mobile station is in discontinuous transmission mode.

SECRET



ABSTRACT OF THE DISCLOSURE

A mobile communications system includes a radio access network, such as an Enhanced General Packet Radio Service (EGPRS) network, in which mobile stations are able to enter into a discontinuous transmission (DTX) mode. During DTX mode of a first mobile station that is allocated a channel portion (e.g., a time slot of a frame), the radio access network is able to multiplex traffic from another mobile station onto the same channel portion. A mechanism is provided to enable the first mobile station to send a request for re-allocation of the channel portion. The request includes a Real-Time FastAssociated Control Channel (RTFACCH) resource request message (RTRRM). In response to the RTRRM, the radio access network sends an RTFACCH resource assignment message (RTUAM).

10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100  
101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111  
112  
113  
114  
115  
116  
117  
118  
119  
120  
121  
122  
123  
124  
125  
126  
127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137  
138  
139  
140  
141  
142  
143  
144  
145  
146  
147  
148  
149  
150  
151  
152  
153  
154  
155  
156  
157  
158  
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169  
170  
171  
172  
173  
174  
175  
176  
177  
178  
179  
180  
181  
182  
183  
184  
185  
186  
187  
188  
189  
190  
191  
192  
193  
194  
195  
196  
197  
198  
199  
200  
201  
202  
203  
204  
205  
206  
207  
208  
209  
210  
211  
212  
213  
214  
215  
216  
217  
218  
219  
220  
221  
222  
223  
224  
225  
226  
227  
228  
229  
230  
231  
232  
233  
234  
235  
236  
237  
238  
239  
240  
241  
242  
243  
244  
245  
246  
247  
248  
249  
250  
251  
252  
253  
254  
255  
256  
257  
258  
259  
260  
261  
262  
263  
264  
265  
266  
267  
268  
269  
270  
271  
272  
273  
274  
275  
276  
277  
278  
279  
280  
281  
282  
283  
284  
285  
286  
287  
288  
289  
290  
291  
292  
293  
294  
295  
296  
297  
298  
299  
300  
301  
302  
303  
304  
305  
306  
307  
308  
309  
310  
311  
312  
313  
314  
315  
316  
317  
318  
319  
320  
321  
322  
323  
324  
325  
326  
327  
328  
329  
330  
331  
332  
333  
334  
335  
336  
337  
338  
339  
340  
341  
342  
343  
344  
345  
346  
347  
348  
349  
350  
351  
352  
353  
354  
355  
356  
357  
358  
359  
360  
361  
362  
363  
364  
365  
366  
367  
368  
369  
370  
371  
372  
373  
374  
375  
376  
377  
378  
379  
380  
381  
382  
383  
384  
385  
386  
387  
388  
389  
390  
391  
392  
393  
394  
395  
396  
397  
398  
399  
400  
401  
402  
403  
404  
405  
406  
407  
408  
409  
410  
411  
412  
413  
414  
415  
416  
417  
418  
419  
420  
421  
422  
423  
424  
425  
426  
427  
428  
429  
430  
431  
432  
433  
434  
435  
436  
437  
438  
439  
440  
441  
442  
443  
444  
445  
446  
447  
448  
449  
450  
451  
452  
453  
454  
455  
456  
457  
458  
459  
460  
461  
462  
463  
464  
465  
466  
467  
468  
469  
470  
471  
472  
473  
474  
475  
476  
477  
478  
479  
480  
481  
482  
483  
484  
485  
486  
487  
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500  
501  
502  
503  
504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543  
544  
545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569  
570  
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594  
595  
596  
597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630  
631  
632  
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668  
669  
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695  
696  
697  
698  
699  
700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716  
717  
718  
719  
720  
721  
722  
723  
724  
725  
726  
727  
728  
729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747  
748  
749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761  
762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773  
774  
775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793  
794  
795  
796  
797  
798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821  
822  
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842  
843  
844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861  
862  
863  
864  
865  
866  
867  
868  
869  
870  
871  
872  
873  
874  
875  
876  
877  
878  
879  
880  
881  
882  
883  
884  
885  
886  
887  
888  
889  
890  
891  
892  
893  
894  
895  
896  
897  
898  
899  
900  
901  
902  
903  
904  
905  
906  
907  
908  
909  
910  
911  
912  
913  
914  
915  
916  
917  
918  
919  
920  
921  
922  
923  
924  
925  
926  
927  
928  
929  
930  
931  
932  
933  
934  
935  
936  
937  
938  
939  
940  
941  
942  
943  
944  
945  
946  
947  
948  
949  
950  
951  
952  
953  
954  
955  
956  
957  
958  
959  
960  
961  
962  
963  
964  
965  
966  
967  
968  
969  
970  
971  
972  
973  
974  
975  
976  
977  
978  
979  
980  
981  
982  
983  
984  
985  
986  
987  
988  
989  
990  
991  
992  
993  
994  
995  
996  
997  
998  
999  
1000  
1001  
1002  
1003  
1004  
1005  
1006  
1007  
1008  
1009  
1010  
1011  
1012  
1013  
1014  
1015  
1016  
1017  
1018  
1019  
1020  
1021  
1022  
1023  
1024  
1025  
1026  
1027  
1028  
1029  
1030  
1031  
1032  
1033  
1034  
1035  
1036  
1037  
1038  
1039  
1040  
1041  
1042  
1043  
1044  
1045  
1046  
1047  
1048  
1049  
1050  
1051  
1052  
1053  
1054  
1055  
1056  
1057  
1058  
1059  
1060  
1061  
1062  
1063  
1064  
1065  
1066  
1067  
1068  
1069  
1070  
1071  
1072  
1073  
1074  
1075  
1076  
1077  
1078  
1079  
1080  
1081  
1082  
1083  
1084  
1085  
1086  
1087  
1088  
1089  
1090  
1091  
1092  
1093  
1094  
1095  
1096  
1097  
1098  
1099  
1100  
1101  
1102  
1103  
1104  
1105  
1106  
1107  
1108  
1109  
1110  
1111  
1112  
1113  
1114  
1115  
1116  
1117  
1118  
1119  
1120  
1121  
1122  
1123  
1124  
1125  
1126  
1127  
1128  
1129  
1130  
1131  
1132  
1133  
1134  
1135  
1136  
1137  
1138  
1139  
1140  
1141  
1142  
1143  
1144  
1145  
1146  
1147  
1148  
1149  
1150  
1151  
1152  
1153  
1154  
1155  
1156  
1157  
1158  
1159  
1160  
1161  
1162  
1163  
1164  
1165  
1166  
1167  
1168  
1169  
1170  
1171  
1172  
1173  
1174  
1175  
1176  
1177  
1178  
1179  
1180  
1181  
1182  
1183  
1184  
1185  
1186  
1187  
1188  
1189  
1190  
1191  
1192  
1193  
1194  
1195  
1196  
1197  
1198  
1199  
1200  
1201  
1202  
1203  
1204  
1205  
1206  
1207  
1208  
1209  
1210  
1211  
1212  
1213  
1214  
1215  
1216  
1217  
1218  
1219  
1220  
1221  
1222  
1223  
1224  
1225  
1226  
1227  
1228  
1229  
1230  
1231  
1232  
1233  
1234  
1235  
1236  
1237  
1238  
1239  
1240  
1241  
1242  
1243  
1244  
1245  
1246  
1247  
1248  
1249  
1250  
1251  
1252  
1253  
1254  
1255  
1256  
1257  
1258  
1259  
1260  
1261  
1262  
1263  
1264  
1265  
1266  
1267  
1268  
1269  
1270  
1271  
1272  
1273  
1274  
1275  
1276  
1277  
1278  
1279  
1280  
1281  
1282  
1283  
1284  
1285  
1286  
1287  
1288  
1289  
1290  
1291  
1292  
1293  
1294  
1295  
1296  
1297  
1298  
1299  
1300  
1301  
1302  
1303  
1304  
1305  
1306  
1307  
1308  
1309  
1310  
1311  
1312  
1313  
1314  
1315  
1316  
1317  
1318  
1319  
1320  
1321  
1322  
1323  
1324  
1325  
1326  
1327  
1328  
1329  
1330  
1331  
1332  
1333  
1334  
1335  
1336  
1337  
1338  
1339  
1340  
1341  
1342  
1343  
1344  
1345  
1346  
1347  
1348  
1349  
1350  
1351  
1352  
1353  
1354  
1355  
1356  
1357  
1358  
1359  
1360  
1361  
1362  
1363  
1364  
1365  
1366  
1367  
1368  
1369  
1370  
1371  
1372  
1373  
1374  
1375  
1376  
1377  
1378  
1379  
1380  
1381  
1382  
1383  
1384  
1385  
1386  
1387  
1388  
1389  
1390  
1391  
1392  
1393  
1394  
1395  
1396  
1397  
1398  
1399  
1400  
1401  
1402  
1403  
1404  
1405  
1406  
1407  
1408  
1409  
1410  
1411  
1412  
1413  
1414  
1415  
1416  
1417  
1418  
1419  
1420  
1421  
1422  
1423  
1424  
1425  
1426  
1427  
1428  
1429  
1430  
1431  
1432  
1433  
1434  
1435  
1436  
1437  
1438  
1439  
1440  
1441  
1442  
1443  
1444  
1445  
1446  
1447  
1448  
1449  
1450  
1451  
1452  
1453  
1454  
1455  
1456  
1457  
1458  
1459  
1460  
1461  
1462  
1463  
1464  
1465  
1466  
1467  
1468  
1469  
1470  
1471  
1472  
1473  
1474  
1475  
1476  
1477  
1478  
1479  
1480  
1481  
1482  
1483  
1484  
1485  
1486  
1487  
1488  
1489  
1490  
1491  
1492  
1493  
1494  
1495  
1496  
1497  
1498  
1499  
1500  
1501  
1502  
1503  
1504  
1505  
1506  
1507  
1508  
1509  
1510  
1511  
1512  
1513  
1514  
1515  
1516  
1517  
1518  
1519  
1520  
1521  
1522  
1523  
1524  
1525  
1526  
1527  
1528  
1529  
1530  
1531  
1532  
1533  
1534  
1535  
1536  
1537  
1538  
1539  
1540  
1541  
1542  
1543  
1544  
1545  
1546  
1547  
1548  
1549  
1550  
1551  
1552  
1553  
1554  
1555  
1556  
1557  
1558  
1559  
1560  
1561  
1562  
1563  
1564  
1565  
1566  
1567  
1568  
1569  
1570  
1571  
1572  
1573  
1574  
1575  
1576  
1577  
1578  
1579  
1580  
1581  
1582  
1583  
1584  
1585  
1586  
1587  
1588  
1589  
1590  
1591  
1592  
1593  
1594  
1595  
1596  
1597  
1598  
1599  
1600  
1601  
1602  
1603  
1604  
1605  
1606  
1607  
1608  
1609  
1610  
1611  
1612  
1613  
1614  
1615  
1616  
1617  
1618  
1619  
1620  
1621  
1622  
1623  
1624  
1625  
1626  
1627  
1628  
1629  
1630  
1631  
1632  
1633  
1634  
1635  
1636  
1637  
1638  
1639  
1640  
1641  
1642  
1643  
1644  
1645  
1646  
1647  
1648  
1649  
1650  
1651  
1652  
1653  
1654  
1655  
1656  
1657  
1658  
1659  
1660  
1661  
1662  
1663  
1664  
1665  
1666  
1667  
1668  
1669  
1670  
1671  
1672  
1673  
1674  
1675  
1676  
1677  
1678  
1679  
1680  
1681  
1682  
1683  
1684  
1685  
1686  
1687  
1688  
1689  
1690  
1691  
1692  
1693  
1694  
1695  
1696  
1697  
1698  
1699  
1700  
1701  
1702  
1703  
1704  
1705  
1706  
1707  
1708  
1709  
1710  
1711  
1712  
1713  
1714  
1715  
1716  
1717  
1718  
1719  
1720  
1721  
1722  
1723  
1724  
1725  
1726  
1727  
1728  
1729  
1730  
1731  
1732  
1733  
1734  
1735  
1736  
1737  
1738  
1739  
1740  
1741  
1742  
1743  
1744  
1745  
1746  
1747  
1748  
1749  
1750  
1751  
1752  
1753  
1754  
1755  
1756  
1757  
1758  
1759  
1760  
1761  
1762  
1763  
1764  
1765  
1766  
1767  
1768  
1769  
1770  
1771  
1772  
1773  
1774  
1775  
1776  
1777  
1778  
1779  
1780  
1781  
1782  
1783  
1784  
1785  
1786  
1787  
1788  
1789  
1790  
1791  
1792  
1793  
1794  
1795  
1796  
1797  
1798  
1799  
1800  
1801  
1802  
1803  
1804  
1805  
1806  
1807  
1808  
1809  
1810  
1811  
1812  
1813  
1814  
1815  
1816  
1817  
1818  
1819  
1820  
1821  
1822  
1823  
1824  
1825  
1826  
1827  
1828  
1829  
1830  
1831  
1832  
1833  
1834  
1835  
1836  
1837  
1838  
1839  
1840  
1841  
1842  
1843  
1844  
1845  
1846  
1847  
1848  
1849  
1850  
1851  
1852  
1853  
1854  
1855  
1856  
1857  
1858  
1859  
1860  
1861  
1862  
1863  
1864  
1865  
1866  
1867  
1868  
1869  
1870  
1871  
1872  
1873  
1874  
1875  
1876  
1877  
1878  
1879  
1880  
1881  
1882  
1883  
1884  
1885  
1886  
1887  
1888  
1889  
1890  
1891  
1892  
1893  
1894  
1895  
1896  
1897  
1898  
1899  
1900  
1901  
1902  
1903  
1904  
1905  
1906  
1907  
1908  
1909  
1910  
1911  
1912  
1913  
1914  
1915  
1916  
1917  
1918  
1919  
1920  
1921  
1922  
1923  
1924  
1925  
1926  
1927  
1928  
1929  
1930  
1931  
1932  
1933  
1934  
1935  
1936  
1937  
1938  
1939  
1940  
1941  
1942  
1943  
1944  
1945  
1946  
1947  
1948  
1949  
1950  
1951  
1952  
1953  
1954  
1955  
1956  
1957  
1958  
1959  
1960  
1961  
1962  
1963  
1964  
1965  
1966  
1967  
1968  
1969  
1970  
1971  
1972  
1973  
1974  
1975  
1976  
1977  
1978  
1979  
1980  
1981  
1982  
1983  
1984  
1985  
1986  
1987  
1988  
1989  
1990  
1991  
1992  
1993  
1994  
1995  
1996  
1997  
1998  
1999  
2000  
2001  
2002  
2003  
2004  
2005  
2006  
2007  
2008  
2009  
2010  
2011  
2012  
2013  
2014  
2015  
2016  
2017  
2018  
2019  
2020  
2021  
2022  
2023  
2024  
2025  
2026  
2027  
2028  
2029  
2030  
2031  
2032  
2033  
2034  
2035  
2036  
2037  
2038  
2039  
2040  
2041  
2042  
2043  
2044  
2045  
2046  
2047  
2048  
2049  
2050  
2051  
2052  
2053  
2054  
2055  
2056  
2057  
2058  
2059  
2060  
2061  
2062  
2063  
2064  
2065  
2066  
2067  
2068  
2069  
2070  
2071  
2072  
2073  
2074  
2075  
2076  
2077  
2078  
2079  
2080  
2081  
2082  
2083  
2084  
2085  
2086  
2087  
2088  
2089  
2090  
2091  
2092  
2093  
2094  
2095  
2096  
2097  
2098  
2099  
2100  
2101  
2102  
2103  
2104  
2105  
2106  
2107  
2108  
2109  
2110  
2111  
2112  
2113  
2114  
2115  
2116  
2117  
2118  
2119  
2120  
2121  
2122  
2123  
2124  
2125  
2126  
2127  
2128  
2129  
2130  
2131  
2132  
2133  
2134  
2135  
2136  
2137  
2138  
2139  
2140  
2141  
2142  
2143  
2144  
2145  
2146  
2147  
2148  
2149  
2150  
2151  
2152  
2153  
2154  
2155  
2156  
2157  
2158  
2159  
2160  
2161  
2162  
2163  
2164  
2165  
2166  
2167  
2168  
2169  
2170  
2171  
2172  
2173  
2174  
2175  
2176  
2177  
2178  
2179  
2180  
2181  
2182  
2183  
2184  
2185  
2186  
2187  
2188  
2189  
2190  
2191  
2192  
2193  
2194  
2195  
2196  
2197  
2198  
2199  
2200  
2201  
2202  
2203  
2204  
2205

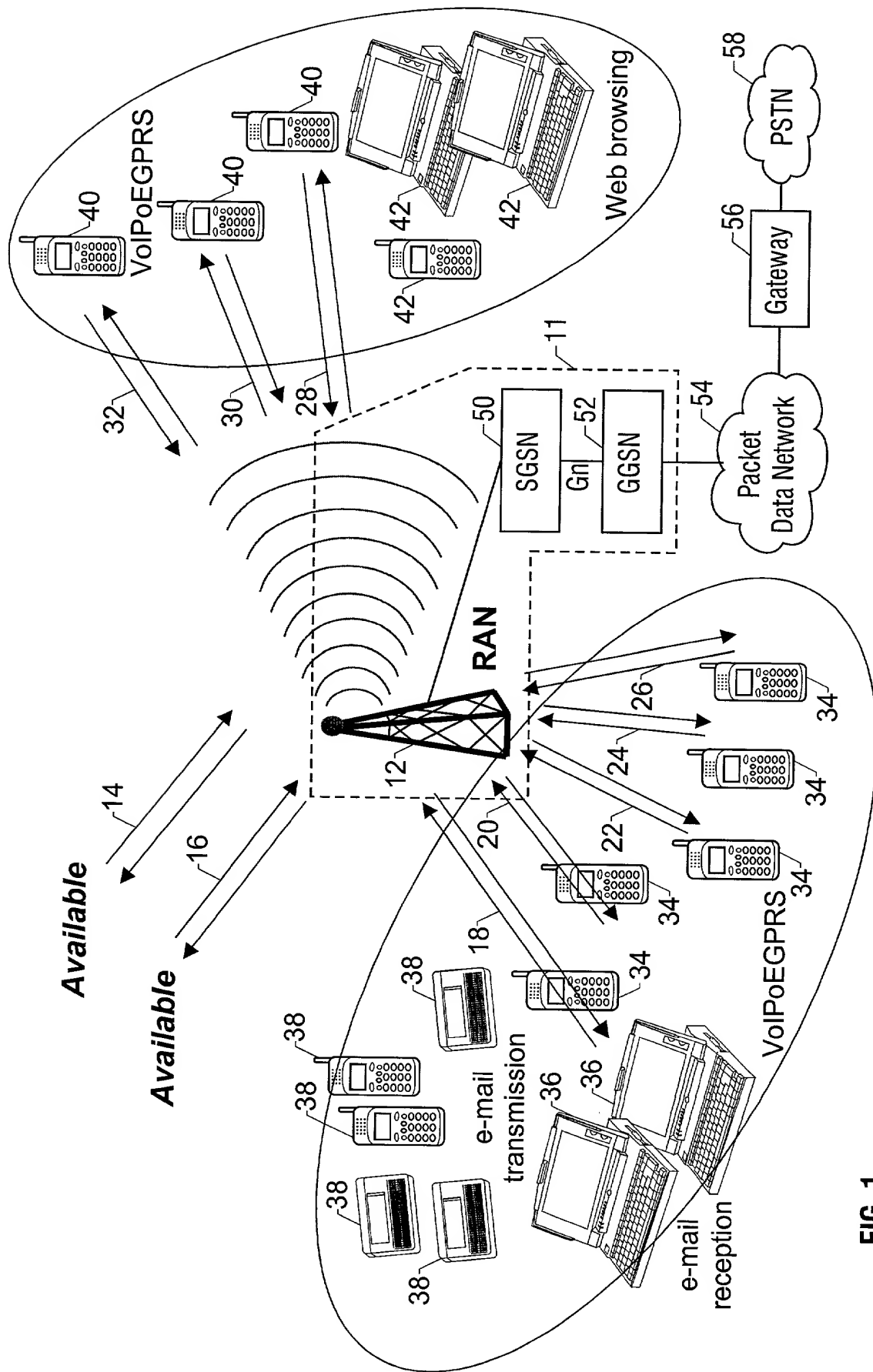


FIG. 1

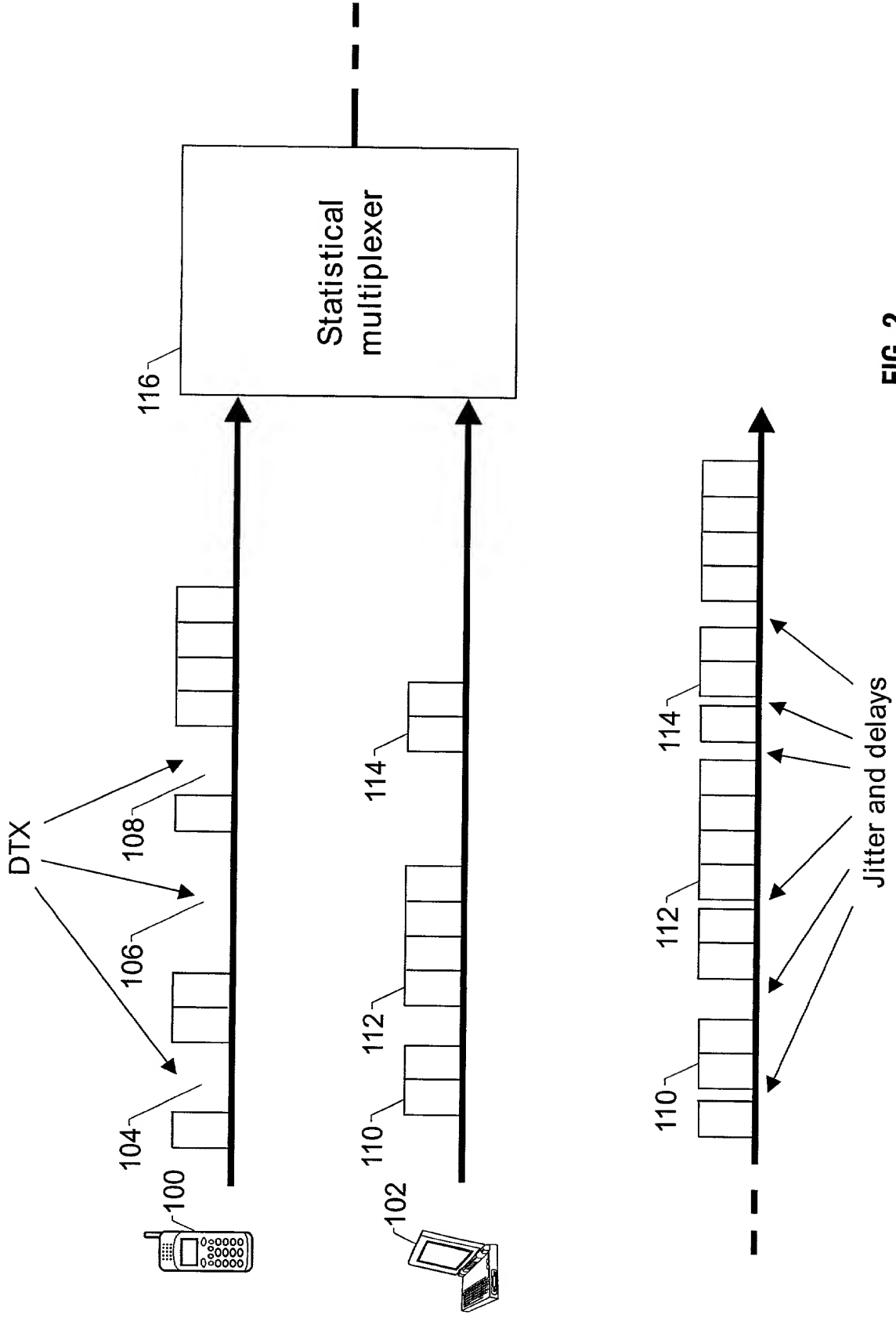


FIG. 2

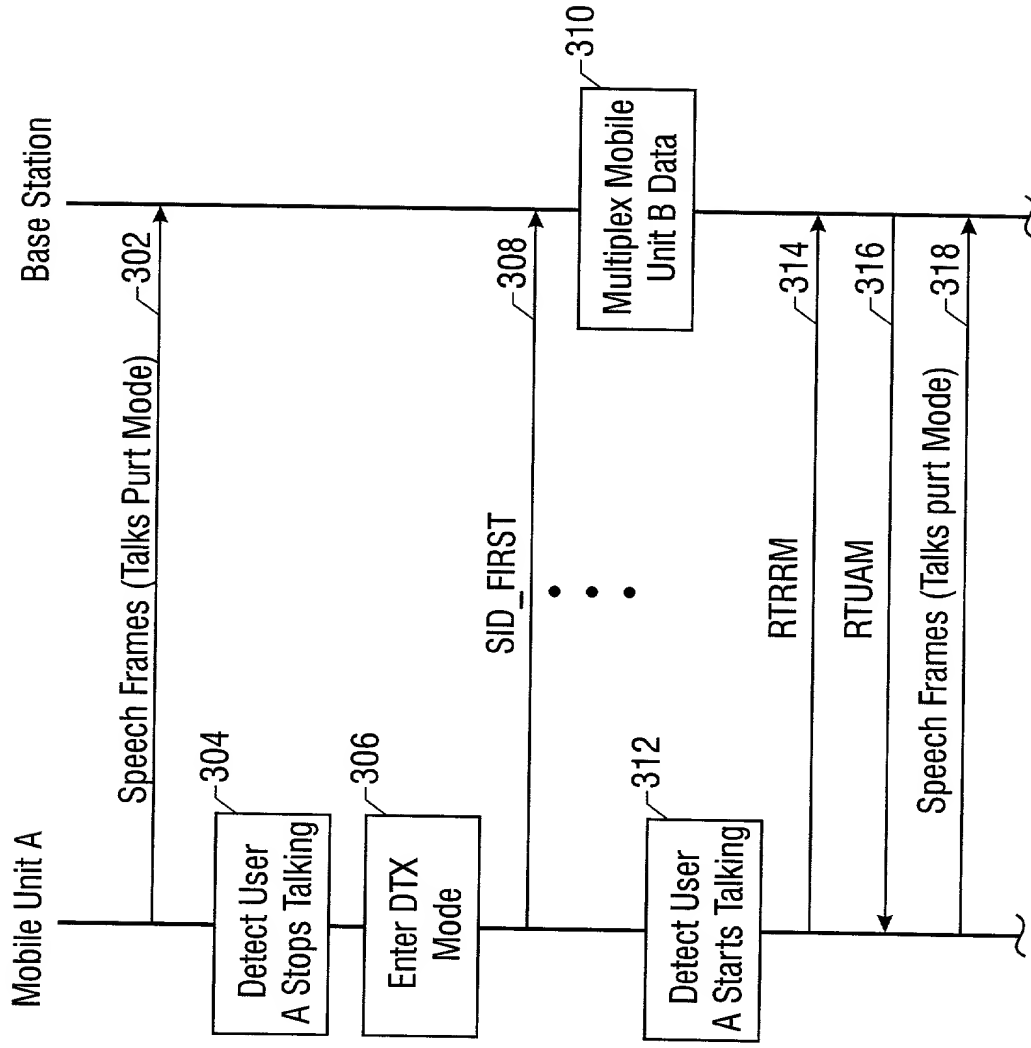


FIG. 3

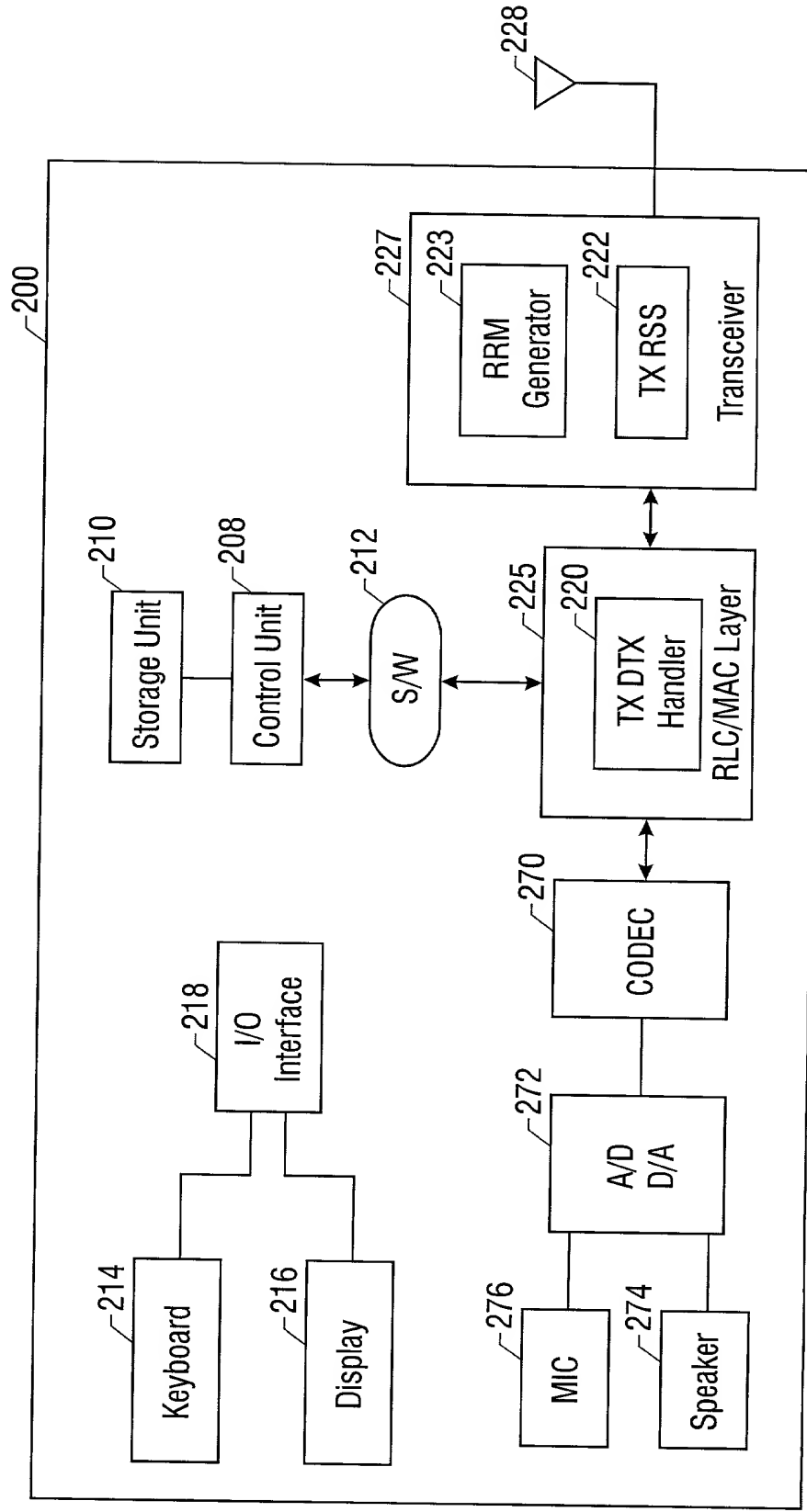


FIG. 4A

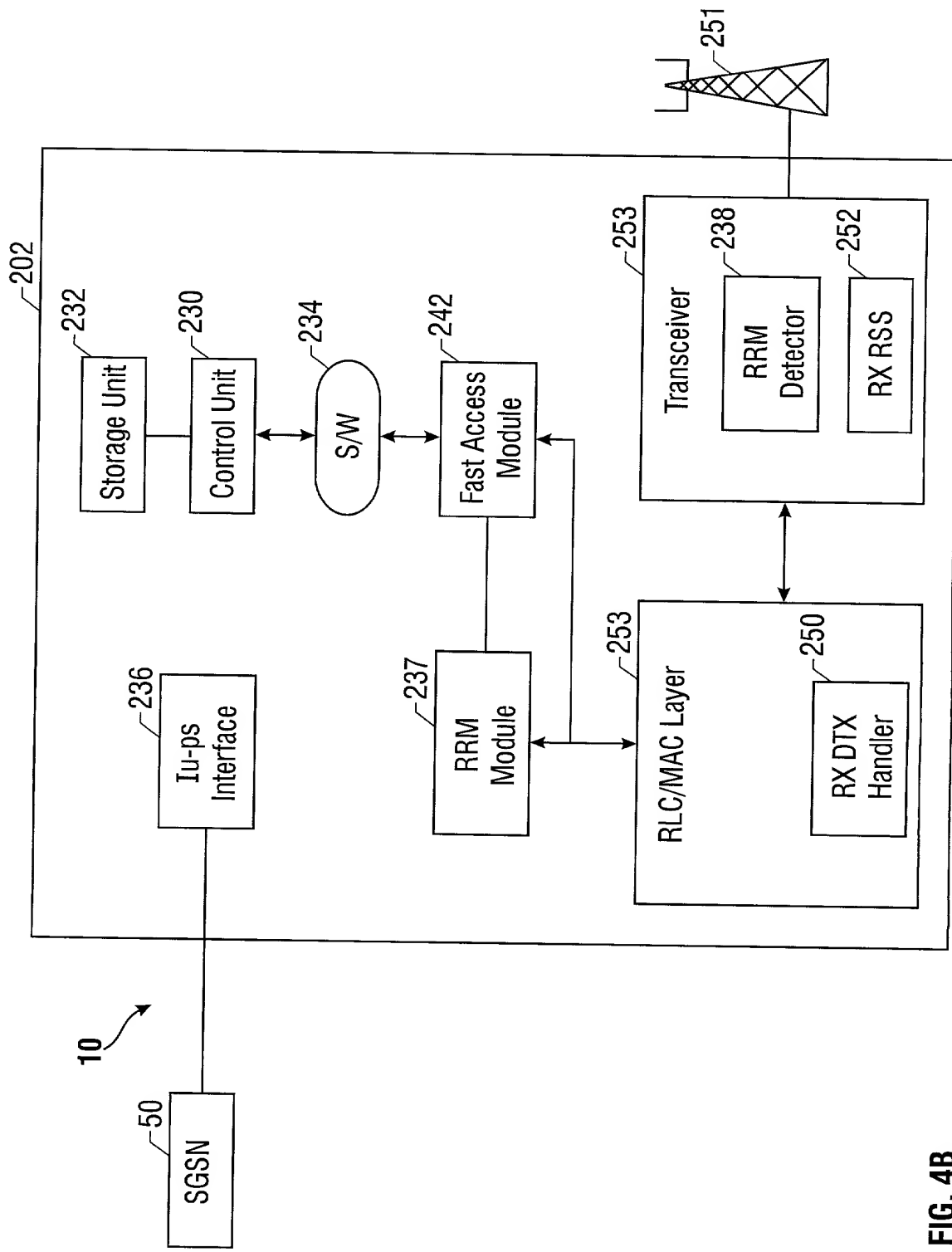


FIG. 4B

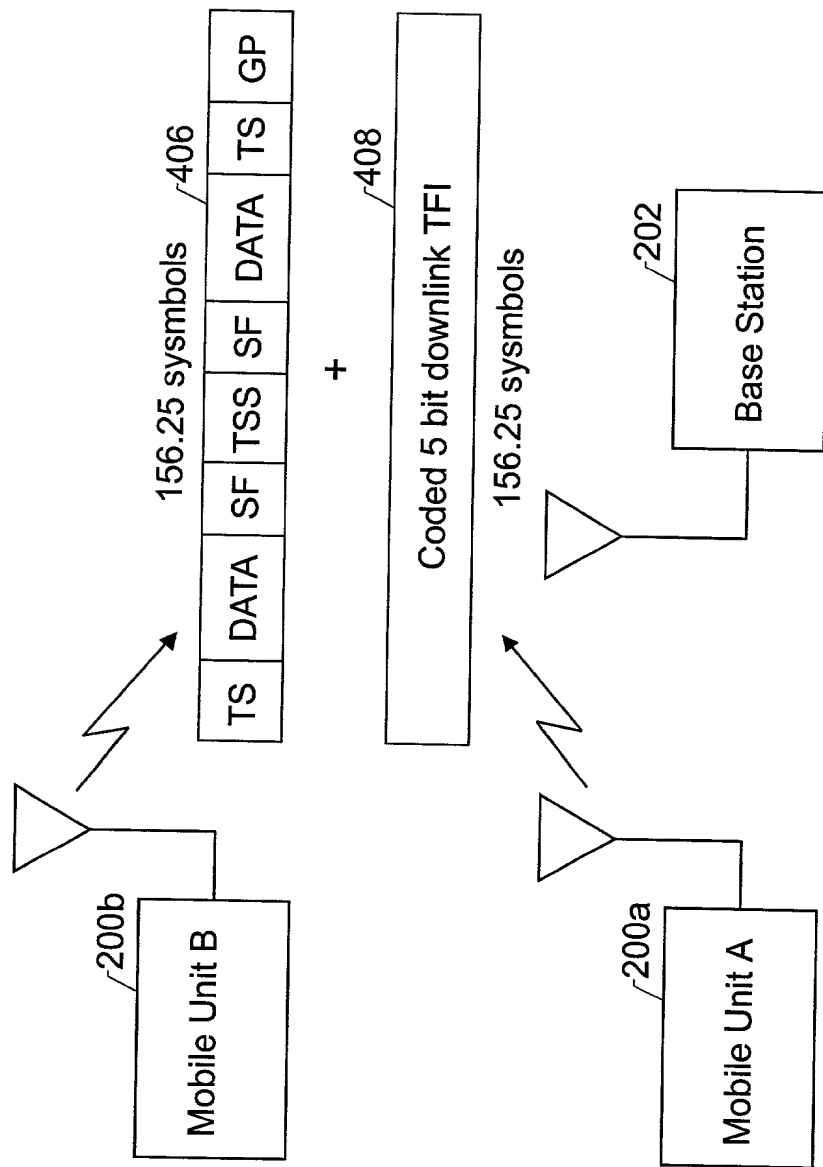


FIG. 5

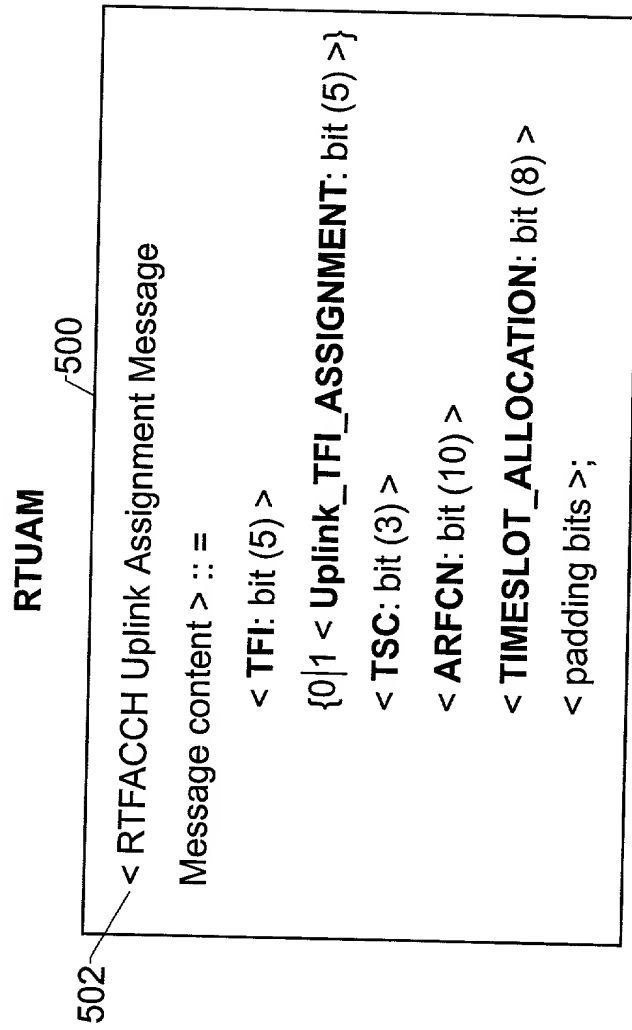


FIG. 6



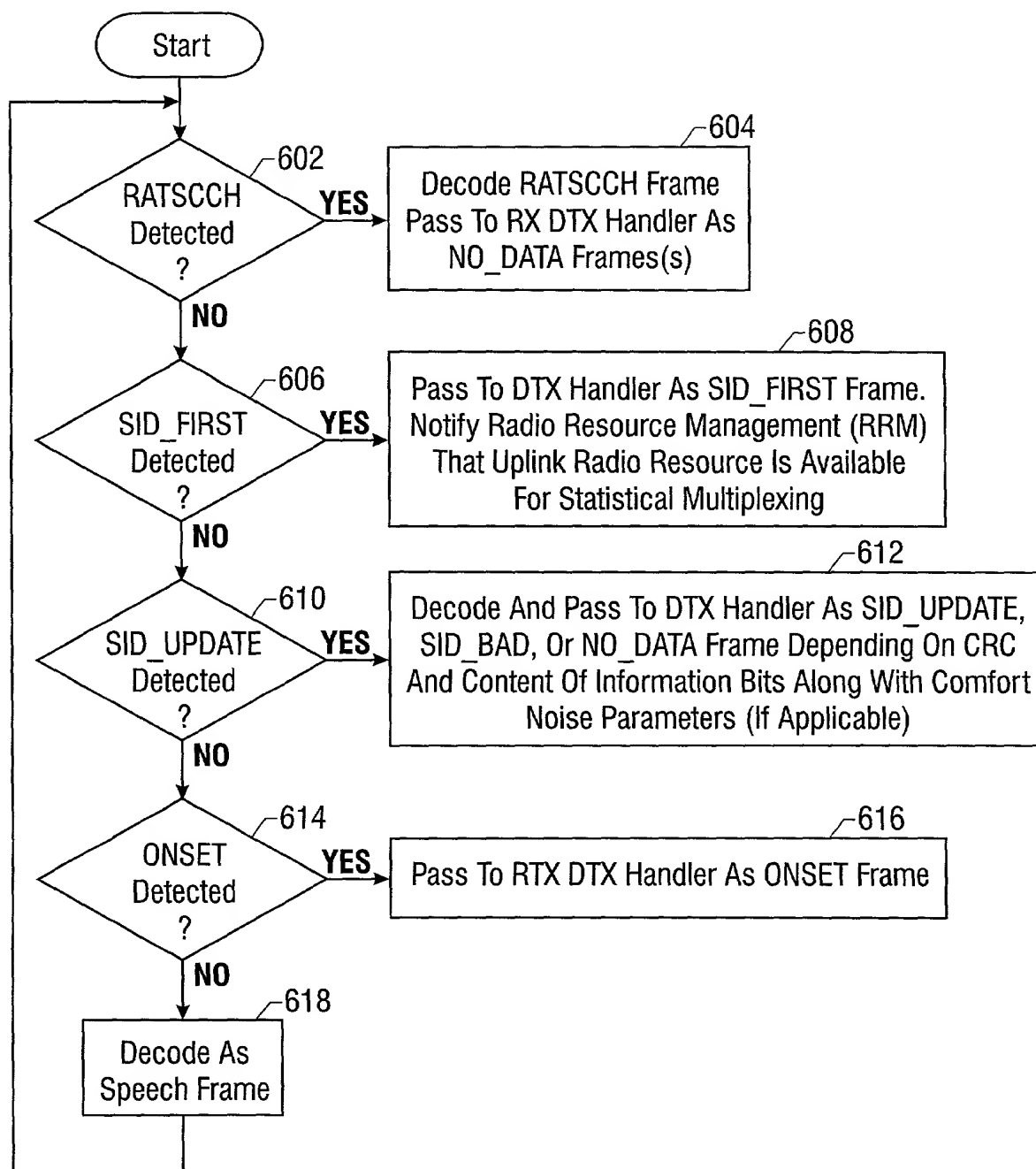


FIG. 7

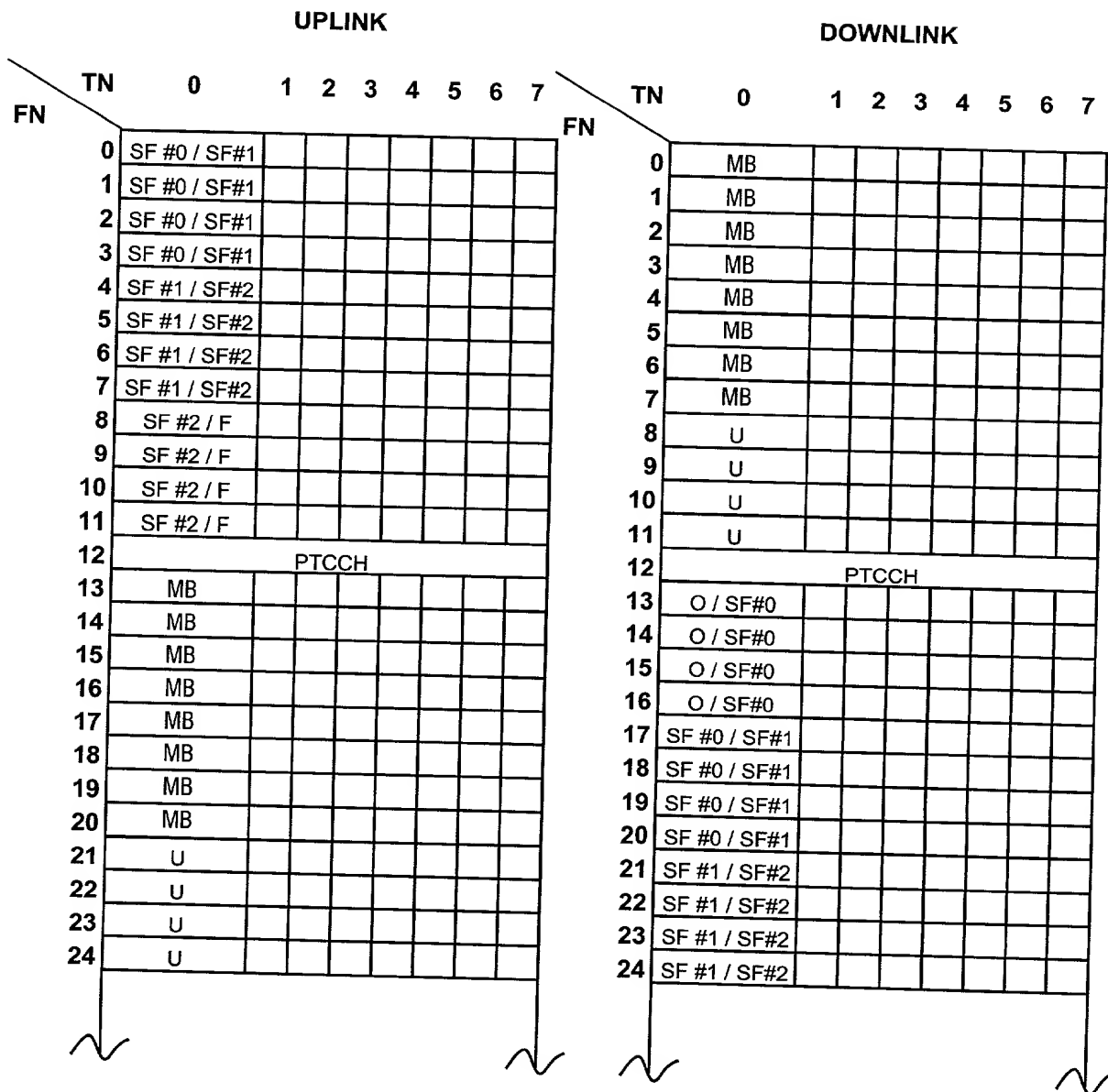
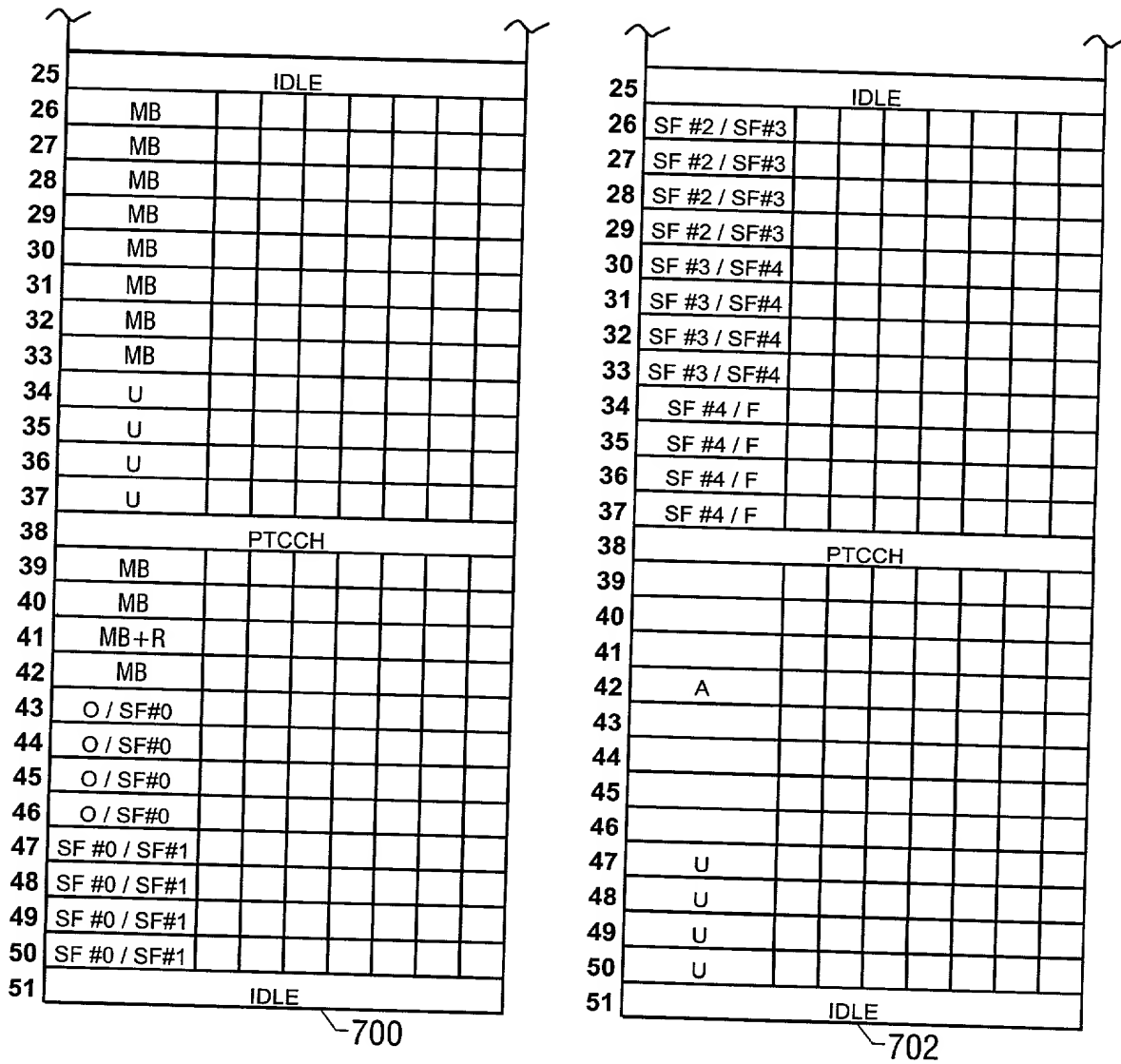


FIG. 8A



Minimum  
Delay

FIG. 8B

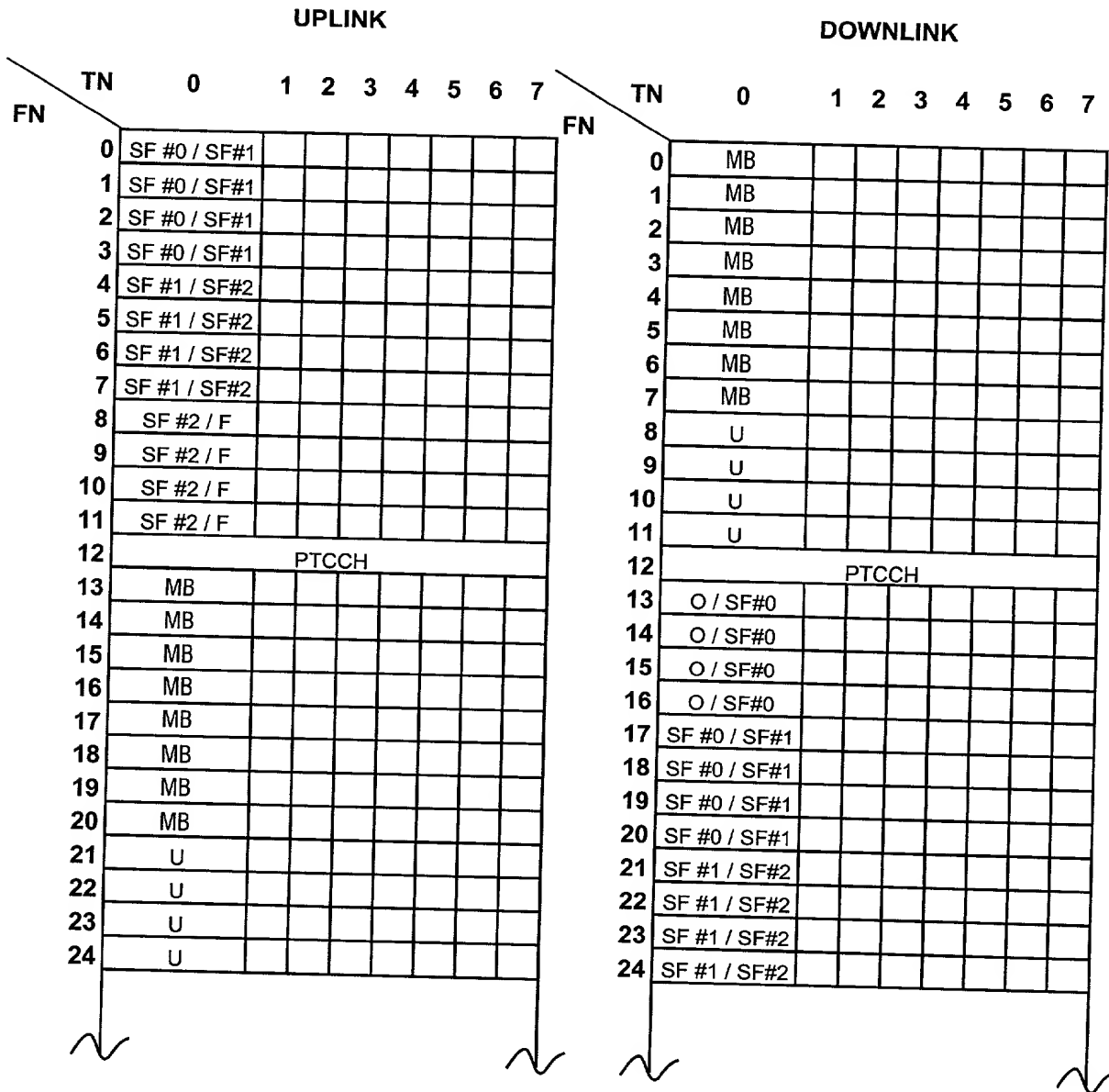
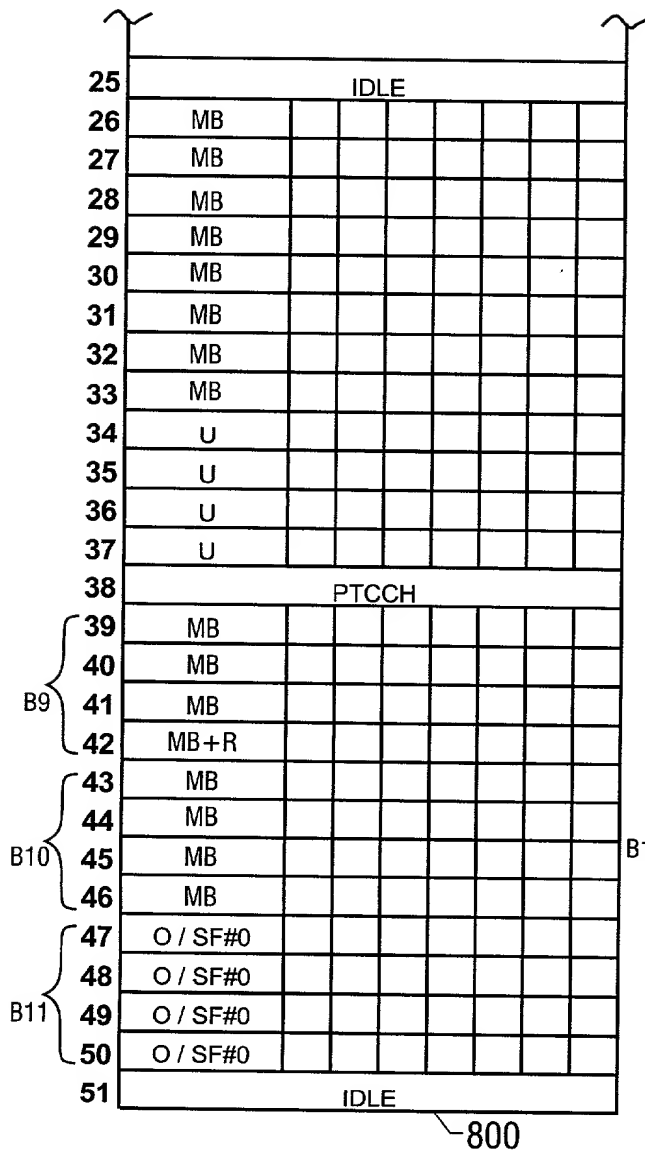


FIG. 9A



Maximum  
Delay

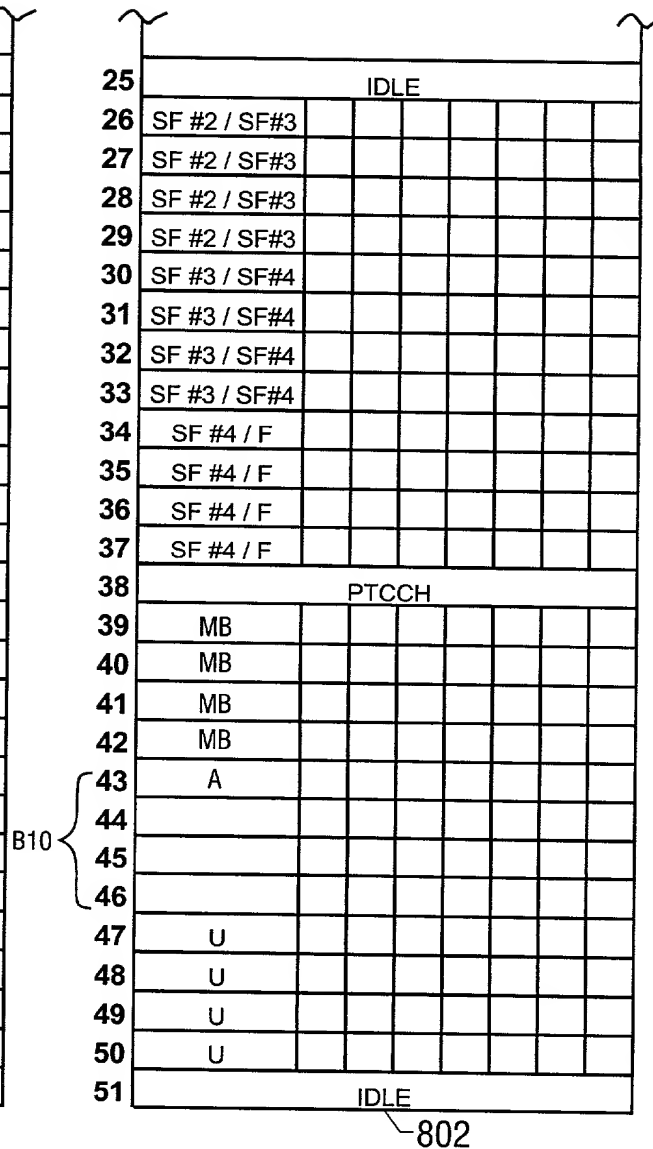


FIG. 9B

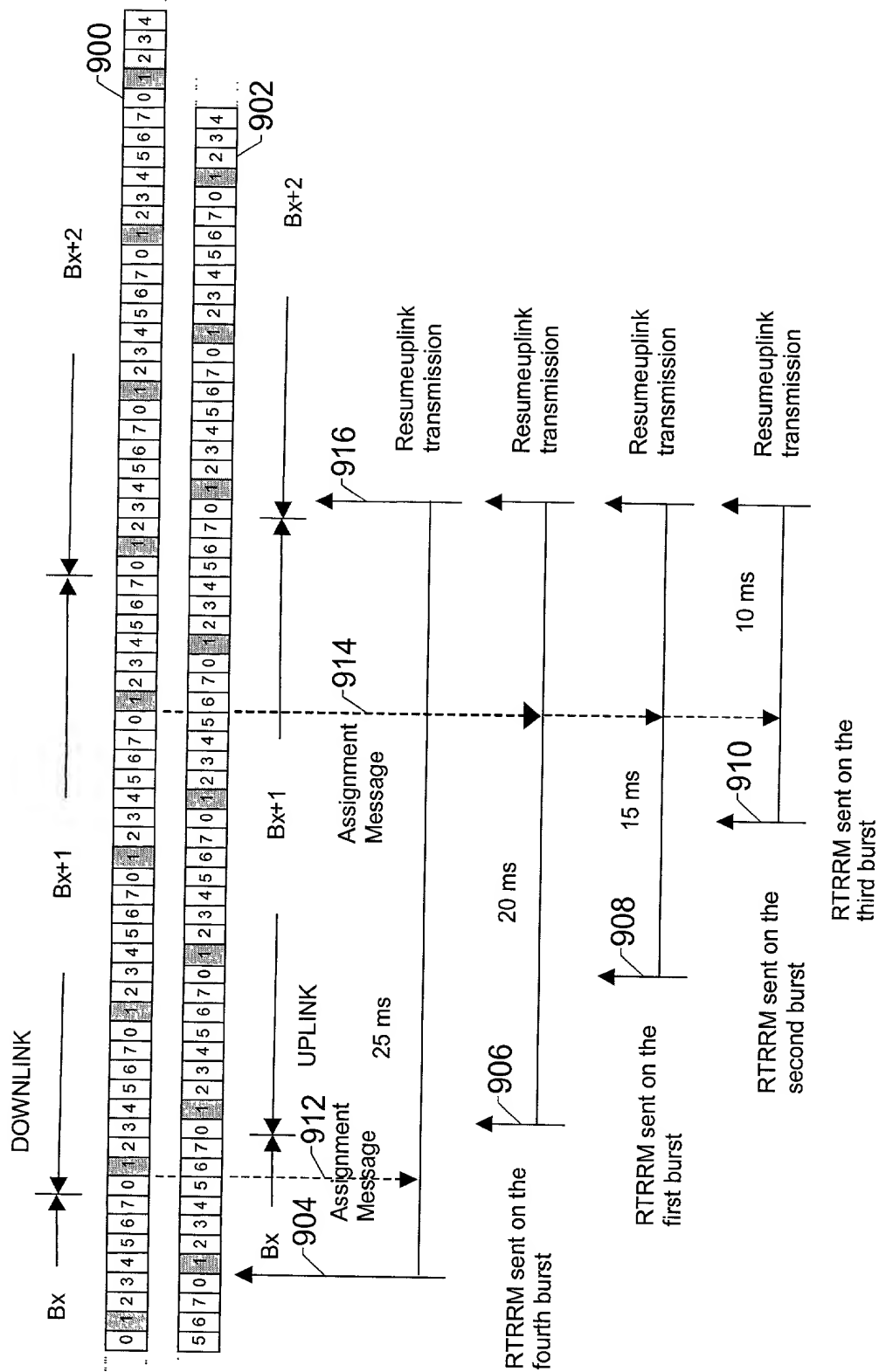


FIG. 10

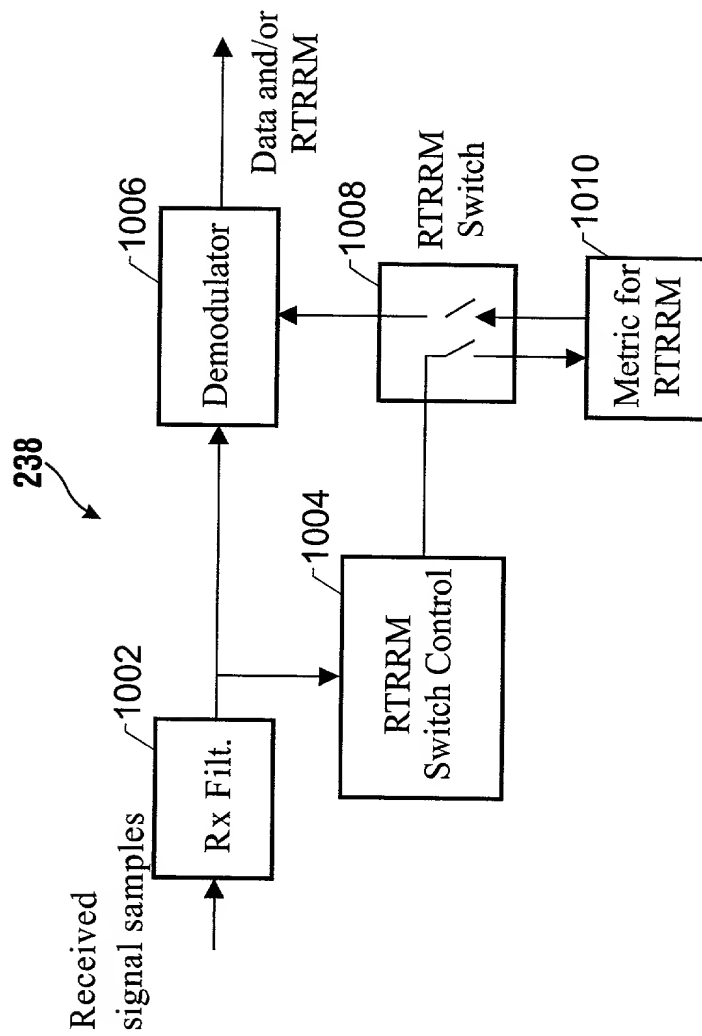


FIG. 11

Attorney's Docket No.: NORT-0070-US (12011RRUS02U)PATENTDECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**COMMUNICATING TRAFFIC OVER A WIRELESS CHANNEL IN A MOBILE  
COMMUNICATIONS SYSTEM**

the specification of which

X

is attached hereto.  
was filed on \_\_\_\_\_ as  
United States Application Number \_\_\_\_\_  
or PCT International Application Number \_\_\_\_\_  
and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate Issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:



<u>Prior Foreign Application(s):</u>			<u>Priority Claimed</u>	
<u>Number</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	<u>Yes</u>	<u>No</u>
<u>Number</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	<u>Yes</u>	<u>No</u>

I hereby claim the benefit under title 35, United States Code, Section 119(e) of the United States provisional application(s) listed below:

<u>60/175,329</u>	<u>01/10/2000</u>
<u>(Application Number)</u>	<u>(Filing Date)</u>
<u>(Application Number)</u>	<u>(Filing Date)</u>

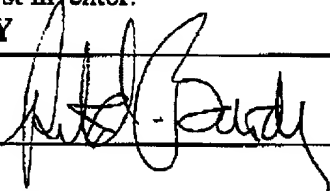
I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

<u>(Application Number)</u>	<u>Filing Date</u>	<u>(Status-patented, pending, abandoned)</u>
-----------------------------	--------------------	--

I hereby appoint Timothy N. Trop, Reg. No. 28,994; Fred G. Pruner, Jr., Reg. No. 40,779, Dan C. Hu, Reg. No. 40,025 and Ruben S. Bains, Reg. No. 46,532; my patent attorneys, of TROP, PRUNER & HU, P.C., with offices located at 8554 Katy Freeway, Ste. 100, Houston, TX 77024, telephone (713) 468-8880, and John D. Crane, Reg. No. 25,231; Howard R. Greenberg, Reg. No. 26,171; W. Glen Johnson, Reg. No. 39,525; Randall Mishler, Reg. No. 42,006; Kevin L. Smith, Reg. No. 38,620; Vernon E. Williams, Reg. No. 38,713; Thomas A. Gigliotti, Reg. No. 37,579; Eric P. Jensen, Reg. No. 37,647; J. Erik Fako, Reg. No. 42,522; John H. Vynalek, Reg. No. 37,254; John R. Witcher, III, Reg. No. 39,877; and R. Todd Morgan, Reg. No. 43,815, my patent attorneys, of Nortel Networks Limited; with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Dan C. Hu, TROP, PRUNER & HU, P.C., 8554 Katy Freeway, Ste. 100, Houston, TX 77024 and direct telephone calls to Dan C. Hu, (713) 468-8880.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor: <b>PETER A. BARANY</b>	
Inventor's Signature: 	Date: 11/17/00
Residence: <b>830 Hills Creek Dr., McKinney, TX 75070</b>	Citizenship: <b>U.S.A.</b>
Post Office Address: <b>830 Hills Creek Dr., McKinney, TX 75070</b>	
Full Name of Second/Joint Inventor: <b>CHANDRA S. BONTU</b>	
Inventor's Signature:	Date:
Residence: <b>18 Deerfield Drive., #1606, Nepean, ON, CANADA K2G4L1</b>	Citizenship: <b>INDIA</b>
Post Office Address: <b>18 Deerfield Drive., #1606, Nepean, ON, CANADA K2G4L1</b>	
Full Name of Third/Joint Inventor: <b>SHAMIM AKBAR RAHMAN</b>	
Inventor's Signature:	Date:
Residence: <b>20 Deerfield Dr., Apt. 206, Nepean, ON, CANADA K2G4L2</b>	Citizenship: <b>CANADA</b>
Post Office Address: <b>20 Deerfield Dr., Apt. 206, Nepean, ON, CANADA K2G4L2</b>	

Attorney's Docket No.: NORT-0070-US (12011RRUS02U)PATENTDECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**COMMUNICATING TRAFFIC OVER A WIRELESS CHANNEL IN A MOBILE  
COMMUNICATIONS SYSTEM**

the specification of which

X	is attached hereto.
	was filed on _____ as
	United States Application Number _____
	or PCT International Application Number _____
	and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):Priority Claimed

<u>Number</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	<u>Yes</u>	<u>No</u>
<u>Number</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	<u>Yes</u>	<u>No</u>

I hereby claim the benefit under title 35, United States Code, Section 119(e) of the United States provisional application(s) listed below:

<u>60/175,329</u>	<u>01/10/2000</u>
<u>(Application Number)</u>	<u>(Filing Date)</u>
<u>(Application Number)</u>	<u>(Filing Date)</u>

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

<u>(Application Number)</u>	<u>Filing Date</u>	<u>(Status-patented, pending, abandoned)</u>
-----------------------------	--------------------	--

I hereby appoint Timothy N. Trop, Reg. No. 28,994; Fred G. Pruner, Jr., Reg. No. 40,779, Dan C. Hu, Reg. No. 40,025 and Ruben S. Bains, Reg. No. 46,532; my patent attorneys, of TROP, PRUNER & HU, P.C., with offices located at 8554 Katy Freeway, Ste. 100, Houston, TX 77024, telephone (713) 468-8880, and John D. Crane, Reg. No. 25,231; Howard R. Greenberg, Reg. No. 26,171; W. Glen Johnson, Reg. No. 39,525; Randall Mishler, Reg. No. 42,006; Kevin L. Smith, Reg. No. 38,620; Vernon E. Williams, Reg. No. 38,713; Thomas A. Gigliotti, Reg. No. 37,579; Eric P. Jensen, Reg. No. 37,647; J. Erik Fako, Reg. No. 42,522; John H. Vynalek, Reg. No. 37,254; John R. Witcher, III, Reg. No. 39,877; and R. Todd Morgan, Reg. No. 43,815, my patent attorneys, of Nortel Networks Limited; with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Dan C. Hu, TROP, PRUNER & HU, P.C., 8554 Katy Freeway, Ste. 100, Houston, TX 77024 and direct telephone calls to Dan C. Hu, (713) 468-8880.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor: <b>PETER A. BARANY</b>	
Inventor's Signature:	Date:
Residence: <b>830 Hills Creek Dr., McKinney, TX 75070</b>	Citizenship: <b>U.S.A.</b>
Post Office Address: <b>830 Hills Creek Dr., McKinney, TX 75070</b>	
Full Name of Second/Joint Inventor: <b>CHANDRA S. BONTU</b>	
Inventor's Signature: <i>Chandra S. Bontu</i>	Date: <i>Nov. 17, 2000</i>
Residence: <b>18 Deerfield Drive., #1606, Nepean, ON, CANADA K2G4L1</b>	Citizenship: <b>INDIA</b>
Post Office Address: <b>18 Deerfield Drive., #1606, Nepean, ON, CANADA K2G4L1</b>	
Full Name of Third/Joint Inventor: <b>SHAMIM AKBAR RAHMAN</b>	
Inventor's Signature:	Date:
Residence: <b>20 Deerfield Dr., Apt. 206, Nepean, ON, CANADA K2G4L2</b>	Citizenship: <b>CANADA</b>
Post Office Address: <b>20 Deerfield Dr., Apt. 206, Nepean, ON, CANADA K2G4L2</b>	

Attorney's Docket No.: NORT-0070-US (12011RRUS02U)PATENTDECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**COMMUNICATING TRAFFIC OVER A WIRELESS CHANNEL IN A MOBILE  
COMMUNICATIONS SYSTEM**

the specification of which

X	is attached hereto.
	was filed on _____ as
	United States Application Number _____
	or PCT International Application Number _____
	and was amended on _____
	(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate Issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):Priority Claimed

<u>Number</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	<u>Yes</u>	<u>No</u>
<u>Number</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	<u>Yes</u>	<u>No</u>

I hereby claim the benefit under title 35, United States Code, Section 119(e) of the United States provisional application(s) listed below:

<u>60/175,329</u>	<u>01/10/2000</u>
<u>(Application Number)</u>	<u>(Filing Date)</u>
<u>(Application Number)</u>	<u>(Filing Date)</u>

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

<u>(Application Number)</u>	<u>Filing Date</u>	<u>(Status-patented, pending, abandoned)</u>
-----------------------------	--------------------	--

I hereby appoint Timothy N. Trop, Reg. No. 28,994; Fred G. Pruner, Jr., Reg. No. 40,779, Dan C. Hu, Reg. No. 40,025 and Ruben S. Bains, Reg. No. 46,532; my patent attorneys, of TROP, PRUNER & HU, P.C., with offices located at 8554 Katy Freeway, Ste. 100, Houston, TX 77024, telephone (713) 468-8880, and John D. Crane, Reg. No. 25,231; Howard R. Greenberg, Reg. No. 26,171; W. Glen Johnson, Reg. No. 39,525; Randall Mishler, Reg. No. 42,006; Kevin L. Smith, Reg. No. 38,620; Vernon E. Williams, Reg. No. 38,713; Thomas A. Gigliotti, Reg. No. 37,579; Eric P. Jensen, Reg. No. 37,647; J. Erik Fako, Reg. No. 42,522; John H. Vynalek, Reg. No. 37,254; John R. Witcher, III, Reg. No. 39,877; and R. Todd Morgan, Reg. No. 43,815, my patent attorneys, of Nortel Networks Limited; with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Dan C. Hu, TROP, PRUNER & HU, P.C., 8554 Katy Freeway, Ste. 100, Houston, TX 77024 and direct telephone calls to Dan C. Hu, (713) 468-8880.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor: <b>PETER A. BARANY</b>	
Inventor's Signature:	Date:
Residence: <b>830 Hills Creek Dr., McKinney, TX 75070</b>	Citizenship: <b>U.S.A.</b>
Post Office Address: <b>830 Hills Creek Dr., McKinney, TX 75070</b>	
Full Name of Second/Joint Inventor: <b>CHANDRA S. BONTU</b>	
Inventor's Signature:	Date:
Residence: <b>18 Deerfield Drive., #1606, Nepean, ON, CANADA K2G4L1</b>	Citizenship: <b>INDIA</b>
Post Office Address: <b>18 Deerfield Drive., #1606, Nepean, ON, CANADA K2G4L1</b>	
Full Name of Third/Joint Inventor: <b>SHAMIM AKBAR RAHMAN</b>	
Inventor's Signature: <i>Shamim Akbar Rahman</i>	Date: <i>Nov. 17, 2000</i>
Residence: <b>20 Deerfield Dr., Apt. 206, Nepean, ON, CANADA K2G4L2</b>	Citizenship: <b>CANADA</b>
Post Office Address: <b>20 Deerfield Dr., Apt. 206, Nepean, ON, CANADA K2G4L2</b>	